Concrete

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Old Ideas for New

LEGISLATION proposed in Indiana, Minnesota, New York, Ohio, Tennessee and Wisconsin to prevent or limit the use of paint spray equipment serves to remind us that Labor has very often resisted the use of labor-saving devices. This has been in spite of the fact that machines which produce more than men can produce increase the world's supply of usable things; add to all our standards of living and, strangely enough, by putting the products of machines within the price-reach of a larger number, so vastly increase the demand for them that there are more jobs than there were before. Not only that, but the jobs are easier to learn, therefore easier to get and man's economic value is increased. As for the paint and spray legislation—Indiana and Ohio killed the bills in committee; in Wisconsin the bill has been tabled indefinitely. The others are hanging fire.

That, however, is but an incident in a general tendency. What we need to better ourselves is to produce more, of better quality, in less time. It is not confined to the use of mechanical things which reduce manual labor and increase the quantity produced. The resistance of labor to these steps in our economic progress is no more insistent than the resistance of the contractor and the manufacturer, the engineer and the architect—all of us, in fact—to that knowledge of the better ways to do things which the constant research of the non-partisan technical man is giving us from day to day.

As many of the young women who spent their time learning shorthand resist the inroads of dictating machines—the commercial application of the phonograph—so do their bosses resist a new idea which would alter their working habits and necessitate the solution of new problems.

There are two or three articles in this issue of Concrete—one for the contractor, one for the products manufacturer, one for the user of building units—which tend to upset the serene order of things, force us to unlearn the half-wisdom of yesterday and give place to the newer, more complete wisdom of today.

It is said that Mr. Ford wastes a lot of money changing building and manufacturing plans after things are started. That may or may not be true. It may be that he would waste more money going ahead with a plan that had become antiquated over night. People who live and work in times like these, where the old order is changing so rapidly, cannot afford to build a fortress around tradition. They must be ready at all times to junk an old idea for a new one.

Even now, less than two years since a great hue and cry went up against the joint committee's proposal to specify concrete by attained strength rather than by proportions, the resistance has greatly lessened. The thing is actually being done. The logical necessity was so great that the *ways* are being found to do it.

The Car Shortage

THE present construction season will have a large part in developing an unusually great shortage of cars. It is not yet entirely too late to move materials early, because crops and coal later on will increase the present shortage. It has been forcefully pointed out that the difficulty is after all not so much a shortage of cars, which may be charged up to the railroads, as a failure on the part of the users of cars to use them anywhere near 100 per cent. Cars are loaded to only half capacity. If shippers will load what cars there are to even so little as a ton more than their present average capacity, the effect will be just the same on freight movement as to add 100,000 cars to the available supply. The car shortage can be whipped by car users, if they will do it.

Brick vs. Brick

THE tests of brick reported in this issue are of very large importance not only to concrete products manufacturers but to the public. If a concrete brick is *more efficient* than a burned clay brick, because of the monolithic character of the masonry of which it is a part, giving much higher strengths in the wall than clay brick of equal unit strength — then concrete brick have a wide economic importance. Not of least importance, perhaps, is the fact that the manufacture of concrete brick (including the cement which is its binder) requires very much less fuel. There is another lesson in these tests — we should not too hastily judge the value of anything in the way of building units by the quality of the individual units. The thing that counts is what happens in the structure.

Relation Between Compressive Strength of Piers and Mortar, Bricks and Transverse Strength of Brick—Concrete Brick Piers

TABLE 11

12-IN. x 12-IN. x 40-IN. CONCRETE BRICK PIERS. RELATION BETWEEN COMPRESSIVE STRENGTH OF PIER AND (*a*) COMPRESSIVE STRENGTH OF MORTAR; (*b*) COMPRESSIVE STRENGTH OF BRICK; (*c*) TRANSVERSE STRENGTH OF BRICK

Series	Kind of Brick	PIER		BRICKS		Absorption in 48 hrs.	Average Age of Pier in Days	Average Age of Brick in Days	RATIO			Weight of Masonry lbs./cu.ft.
		Average Compressive Strength, lbs./sq.in.	Average Compressive Strength of Mortar, lbs./sq.in.	Average Compressive Strength, lbs./sq.in.	Average Transverse Strength, lbs./sq.in.				(*a*) (1) ÷ (2)	(*b*) (1) ÷ (3)	(*c*) (1) ÷ (4)	
		(1)	(2)	(3)	(4)							
A-VI	1 Cement, 5 Sand	1030 1318	2230 2604	1383 1388	300 366	9.9 9.9	28 91	81 144	.462 .506	.745 .950	3.43 3.60	121.2
A-VII	1 Cement, 4 Sand	1784 1955	2682 3280	2678 2610	486 467	11.8 11.8	28 90	250 312	.665 .596	.666 .749	3.67 4.19	125.1
A-VIII	1 Cement, 7 Sand	1490 1647	1960 2450	1923 1892	524 512	9.8 9.8	28 95	61 128	.760 .672	.775 .871	2.84 3.22	125.6
A-IX	1 Cement, 5 Sand	1806 2159	2222 2542	2545 2529	630 547	9.6 9.6	28 93	96 161	.813 .849	.710 .854	2.87 3.95	128.9
A-X	1 Cement, 5 Sand, 2½ Cinders	1569 2008	2586 2331	2462 2508	492 522	11.2 11.2	29 92	94 157	.607 .861	.637 .801	3.19 3.85	123.8
C-II	1 Cement, 6 Sand	1346	2099	1853	437	10.8	33	62	.641	.726	3.08	
C-III	1 Cement, 4 Sand	1840	2442	3446	638	9.3	32	62	.753	.534	2.88	
B-III	Miscellaneous	2032	1450	4704	824	8.8	34	62	1.401	.432	2.47	
B-IV	.... Mixtures not Recorded at Request of Manufacturer	2167	1663	4086	751	9.6	33	62	1.303	.530	2.89	
B-V	....	1649	1598	2544	538	10.9	34	63	1.032	.648	3.07	
B-VI	....	1992	1934	3598	709	8.7	33	63	1.030	.554	2.81	
B-VII	....	1610	1784	2329	530	10.8	33	64	.902	.691	3.04	
B-VIII	....	1136	1898	1827	377	11.8	33	65	.599	.622	3.02	
B-IX	....	1568	1707	2737	553	9.2	31	65	.919	.573	2.84	
B-X	....	1262	1654	2056	471	10.3	32	66	.763	.614	2.68	
B-XI	....	1066	1614	1500	325	12.3	32	66	.660	.711	3.28	
B-XII	....	1982	1644	3176	621	9.0	28	64	1.206	.624	3.19	
B-XIII	....	846	2400	1150	274	12.7	32	69	.353	.736	3.09	

TABLE 12

12-IN. x 12-IN. x 84-IN. CONCRETE BRICK PIERS. RELATION BETWEEN COMPRESSIVE STRENGTH OF PIER AND (*a*) COMPRESSIVE STRENGTH OF MORTAR; (*b*) COMPRESSIVE STRENGTH OF BRICK; (*c*) TRANSVERSE STRENGTH OF BRICK

Series	Kind of Brick	PIER		BRICKS		Absorption in 48 hrs.	Average Age of Pier in Days	Average Age of Brick in Days	Ratio (*a*) (1) ÷ (2)	Ratio (*b*) (1) ÷ (3)	Ratio (*c*) (1) ÷ (4)
		Average Compressive Strength, lbs./sq.in.	Average Compressive Strength of Mortar, lbs./sq.in.	Average Compressive Strength, lbs./sq.in.	Average Transverse Strength, lbs./sq.in.						
		(1)	(2)	(3)	(4)						
A-VI	Concrete	1140 1358	2659 2864	1383 1388	300 366	9.86 9.86	31 90	81 144	.429 .474	.824 .978	3.80 3.71
A-VII	Concrete	1832 2078	2377 3206	2678 2610	486 467	11.83 11.83	28 92	250 312	.771 .648	.684 .796	3.77 4.45
A-VIII	Concrete	1394 1469	2836 2277	1923 1892	524 512	9.81 9.81	28 90	61 128	.492 .645	.725 .776	2.66 2.87
A-IX	Concrete	1930 2151	2139 2290	2545 2529	630 547	9.61 9.61	29 89	96 161	.902 .939	.758 .851	3.06 3.93
A-X	Concrete	1759 1947	1245* 2617	2462 2508	492 522	11.20 11.20	28 89	94 157	1.413* .744	.714 .776	3.58 3.73

*Defective specimens.

Concrete Brick Make Stronger Masonry

Abstract of a Report of Tests by Albin H. Beyer and William J. Krefeld, of Columbia University

"Comparative Tests of Clay, Sand-Lime and Concrete Brick Masonry" is the title of a publication[1] shortly to be issued by Columbia University. Its effect is certain to be a vastly strengthened position for concrete brick. The report is by Albin H. Beyer, Director of Testing, and William J. Krefeld, Engineer of Tests, of Columbia's Department of Civil Engineering; it bears out and greatly adds to the commercial and engineering importance of concrete brick as indicated by tests reported in CONCRETE for July, 1922, in a paper by Herbert A. Davis.

Concrete brick have been made for many years, usually on a small scale as a concrete products sideline, and as such neither made much money for their producers nor attracted any considerable attention as a masonry unit with large possibilities. In very recent years the brick market has been such in some localities as to encourage large investment in concrete brick plants, with automatic equipment suited to quantity production and uniform, quality results.

The New York market has been successfully invaded by the concrete brick. This fact developed, in the Bureau of Buildings, a very natural interest in the characteristics of concrete brick and a demand for definite knowledge of what might be expected of it in service as compared with established materials, so long in use that there was little or no question of their quality or supremacy. It has not been uncommon to see concrete brick disparaged as "substitute" brick.

In the consideration of building units it is usual to rate them by a comparison of their individual strengths. As a matter of fact, nobody cares what load one brick or one block will withstand before crushing, except as such individual strength is supposed to afford some indication of the strength of the structure into which such units are built. Columbia University tests establish a very great difference between the load supporting value of individual units and the load-supporting value of a pier built of the same kind of units. The load-supporting value of a pier or wall depends not merely upon the building units of which it is constructed but upon the mortar in which they are laid, and most of all the strength of the pier or wall depends upon the *relationship between the unit and the mortar*—upon the extent to which the mortar and the unit work together as a monolith.

The Columbia tests show that concrete brick with a compressive strength of 1500 lbs. per sq. in.—the poorest concrete brick tested—make piers that will withstand a load of from 1070 to 1210 lbs. per sq. in., while clay brick having a unit compressive strength of 3000 lbs. per sq. in. make piers that will withstand loads of 740 to 1270 lbs. per sq. in.; concrete bricks having a unit compressive strength of 4000 lbs. per sq. in.—the strongest concrete brick tested—give pier strengths of 2170 to 2450 lbs. per sq. in., while clay brick testing at 5000 lbs. per sq. in. give pier strengths of 1220 to 2120 lbs. per sq. in.

Quoting from the Columbia report:

> The physical properties of the component parts of a composite structure such as brick masonry are not in themselves a sufficient indication of its strength. The strength of brick masonry can, however, be determined if the relation between the strength of the masonry and the strength of its component parts is established. This relation for brick masonry can be established only as a result of information secured from tests.
>
> The relation between the strength of the brick and the strength of the resultant masonry is an extremely complex one. It depends not only upon the strength of the brick, its size, bonding, mortar strength and thickness of mortar joint, but also upon the kind of material in the brick.
>
> The investigation made in these laboratories indicates:
>
> 1. The ratio between the compressive strength of masonry and

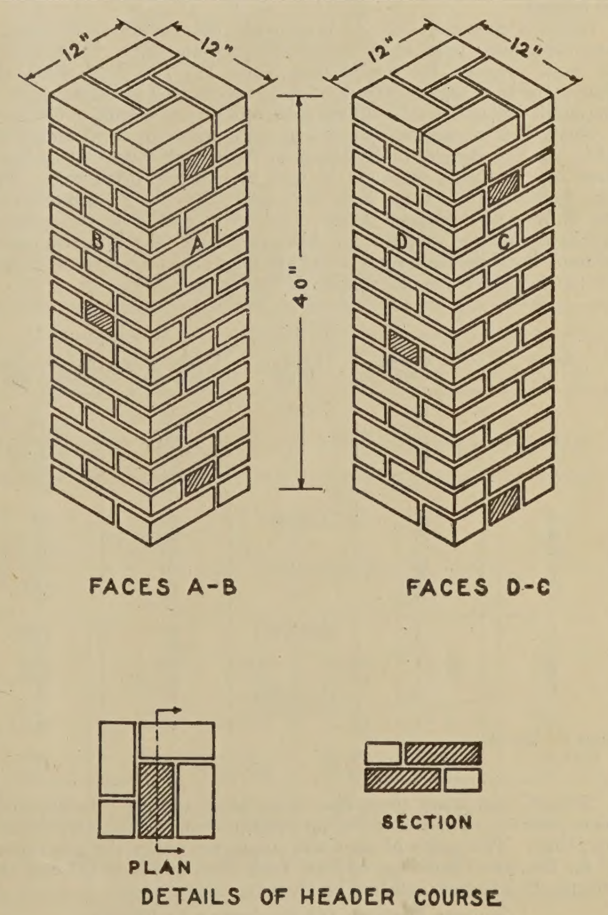

FIG. 1—(PLATE 1 OF REPORT)—DETAILS OF CONSTRUCTION OF 40-IN. BRICK PIERS

the compressive strength of brick varies with the kind of brick even when the compressive and transverse strength of the bricks are the same and all other variables are maintained constant.

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[1] To be issued as Bulletin No. 2, Department of Civil Engineering, Columbia University.

2. The ratio between the elastic limit and the ultimate strength of masonry varies with the kind of brick in otherwise similar masonry.

3. The loss of strength with height of pier is not the same in masonry composed of different kinds of brick.

Three kinds of common building brick, clay, sand-lime and concrete, all of which are approved and used in New York City, were investigated. This investigation was limited to the influence of the kind of brick upon the strength of the masonry, and, accordingly, all other variables such as size of brick, mortar, thickness of joint, type of bonding, curing and age, were kept constant. In order that the masonry would be truly representative of that used in the metropolitan district, these laboratories invited the Bureau of Buildings of the City of New York to cooperate in the selection of materials and construction of the masonry piers. The representatives of the Bureau of Buildings selected the materials as hereinafter described, and witnessed the construction and testing of many of the piers.

This investigation was financed entirely by Columbia University, in large part from a fund established for research in Civil Engineering by Mr. and Mrs. William R. Peters in memory of their son, William Richmond Peters, Jr.

EXTENT OF INVESTIGATION

The conclusions reached in this investigation are based upon the results of tests made upon 135 masonry piers, all 12 in. square; 115 were 40 in. in height, and 20 were 84 in. in height (Fig. 1). The clay, concrete and sand-lime bricks used in the construction of the piers, unless otherwise stated, were intended to be representative of the commercial product used in New York City. In building the piers, an effort was made, insofar as this was practical, to secure uniformity in bonding, quality of mortar, thickness of mortar joints and workmanship. All piers were built by experienced bricklayers using a 1:3 portland cement mortar. The addition of a certain quantity of lime to replace an equal volume of portland cement in the mortar, as is frequently done, was considered, but not deemed desirable, as this would have a tendency to broaden the investigation to include also the effect of lime in portland cement mortar upon the strength of the masonry.

The number of each kind of pier constructed, the corresponding height of pier and age at test, are given in Table 1.

For the purpose of differentiation the pier tests have been subdivided into three distinct series denoted A, B and C, respectively, as follows:

Series A comprises 32 clay brick piers, 40 concrete brick piers, 8 sand-lime brick piers and 4 monolithic concrete piers. In this series of tests, covering the period from June, 1921, to July, 1922, the Bureau of Buildings of New York City cooperated in the selection of materials and witnessed both the construction and testing of the piers.

Series B is an extensive series of tests, made in April and May, 1921, for the Bureau of Buildings of New York City. It covers 9 tests on clay brick piers and 33 tests on concrete brick piers. The clay bricks used in these tests were selected in the open market by the Bureau of Buildings of New York City, and all of the concrete bricks were made specially for this series, under the Bureau's supervision. Both the construction and testing of the piers were witnessed by representatives of the Bureau of Buildings.

TABLE 1

Series	No. of Piers Tested	Kind of Brick	Height of Pier in Inches	Average Age of Pier in Days
A	12	Clay	40	29
B	9	"	40	29
C	3	"	40	31
A	12	"	40	91
A	4	"	84	29
A	4	"	84	92
A	15	Concrete	40	29
B	33	"	40	32
C	6	"	40	32
A	15	"	40	91
A	5	"	84	29
A	5	"	84	92
A	3	Sand Lime	40	29
A	3	"	40	92
A	1	"	84	28
A	1	"	84	92
A	2	Monolithic Concrete	40	28
A	2	"	40	91
Total Number of Piers	135			

Series C comprises three clay brick piers and six concrete brick piers constructed and tested in our laboratory in October and November, 1920. This series of tests was conducted under the supervision of the Bureau of Buildings of New York City, and both the clay and concrete bricks were selected by their representatives.

SOURCE, HISTORY AND SELECTION OF BRICKS

Twenty-six different lots of brick were tested, both as individual bricks and in the form of masonry piers. Of this number seven were clay, one sand-lime and eighteen concrete. The source, history and selection of these bricks are as follows:

A-I. Down-draft, Re-pressed, Common Clay Brick. These bricks were secured from a plant located in the clay district of northeastern New Jersey and were manufactured according to the following process. The clay properly prepared was taken to a brick machine where it was forced through a die, end cut and sanded on four sides. The bricks were then re-pressed and dried in radiation driers. They were burned in permanent kilns of the down-draft type. The bricks were selected from the stock pile at the plant by an engineer of the Bureau of Buildings of New York City.

A-II. Up-draft, Re-pressed, Common Clay Brick. These came from the same source as bricks A-I. The process of manufacture also was identical, except that they were fired in permanent, up-draft kilns. They were also selected from stock at the plant by a representative of the Bureau of Buildings, City of New York.

A-III. Hudson River, Soft Mud Clay Brick. These bricks were manufactured in the season of 1920 in the Hudson Valley District in accordance with the soft mud process. After preliminary air drying they were burned for six to seven days in temporary kilns commonly known as Dutch kilns. The bricks were selected by a representative of the Bureau of Buildings from a boat shipment. The manufacturer stated that in 1920 both the labor and fuel conditions were generally bad in the Hudson Valley District, which made it difficult to obtain at all times a uniform product.

A-IV. Hudson River, Soft Mud Clay Brick. These were obtained from a dealer in New York City and were selected from a lot shipment by a representative of the Bureau of Buildings.

A-V. Sand-lime Brick. These bricks were obtained directly from a manufacturer in northeastern New Jersey. They were not selected at the plant, but were described by the manufacturer as taken from a commercially made lot of bricks sold to the trade. These bricks are approved by the Bureau of Buildings for use in New York City.

A-VI. Concrete Brick. These bricks were made by Peerless brick machines fed by a continuous concrete mixer and stored for two days in curing tunnels and under sheds. They were made on June 9, 1921, using one part of Portland cement to five parts of bank gravel aggregate (glacial drift) screened through a one-eighth inch screen. They were selected from the stock pile at the plant by a representative of the Bureau of Buildings.

A-VII. Concrete Brick. These bricks were made during November, 1920, at the same plant as those marked A-VI. The proportions were one part of portland cement to four parts of bank gravel aggregate screened through a one-eighth inch screen. The process of manufacture was also the same as for bricks A-VI. They were selected from an outdoor stock pile at the plant by a representative of the Bureau of Buildings.

A-VIII. Concrete Brick. These bricks were made at a plant located in the Metropolitan District of New York using a specially designed machine for molding them from concrete having a consistency usually referred to as a "wet mix" supplied by a batch mixer. The dimensions of these bricks were 2¼ in. x 3⅜ in. x 8 in. The concrete consisted of one part portland cement and seven parts of pit sand passing a three-eighths inch screen. The molded bricks were cured in rooms supplied with humidified air followed by outdoor storage. They were made July 2, 1921, and selected at the plant from a stock pile of bricks made for the open market.

A-IX. Concrete Brick. These were made on June 18, 1921, at the same plant as those marked A-VIII. They were described as "face size No. 10 brick" and had the dimensions of 2¼ in. x 3¾ in. x 8 in. They were composed of one part of Portland cement and five parts of three-eighths inch screened sand secured from the plant pit. These bricks were made in accordance with the usual plant methods and were selected at the plant from the stock pile.

A-X. Concrete Brick. These bricks were made on June 15, 1921, at the same plant as those marked A-VIII and A-IX. They were described as "face size No. 20 brick," having the dimensions 2½ in. x 2¾ in. x 8 in., and were composed of one part of portland cement, two and one-half parts of cinders and five parts of plant sand. They were made in accordance with the usual plant methods and were selected from the stock pile at the plant.

B-I and B-II. Hudson River Clay Brick. These two lots of common Hudson River "soft mud" clay bricks made by two different clay brick manufacturers were obtained from the supply yards of two different dealers in building materials in the Metropolitan District of New York City. They were selected and marked for identification by representatives of the Bureau of Buildings of the City of New York.

B-III to B-XIII Inclusive. Concrete Brick. These bricks, representing eleven different experimental mixtures of concrete brick, were made at the same plant from which the bricks marked A-VIII, A-IX and A-X were obtained. The proportions of portland cement and aggregates used varied over a wide range. At the request of the manufacturer, the proportions of the mixtures used are not recorded herein. The bricks were specially made under the supervision of the Bureau of Buildings of the City of New York for the purpose of obtaining experimental data concerning the physical properties of the individual bricks and masonry constructed therefrom. The testing of these bricks and the corresponding piers was done under the supervision of above representatives.

C-I. Hudson River Clay Brick. These were common clay bricks made by a Hudson River clay brick manufacturer and obtained from a dealer in building materials in the Metropolitan District of New York City. They were selected by the Bureau of Buildings of New York City.

C-II and C-III. Concrete Brick. These bricks were made at the same plant from which bricks marked A-VIII, A-IX and A-X were obtained, in accordance with the method in use at this plant. Their composition was one part of portland cement to six parts of plant sand, and one part of portland cement to four parts of plant sand, respectively.

With the exception of concrete bricks B-III to B-XIII, inclusive, all those tested, both as individual bricks and in the form of masonry piers, were intended to be representative of commercial common building bricks used in the Metropolitan District of New York City.

TABLE 2—PHYSICAL PROPERTIES OF CLAY AND SAND-LIME BRICKS USED IN CONSTRUCTION OF PIERS

Series	Kind of Brick	Compressive Strength, lbs./sq.in.	Modulus of Rupture, lbs./sq.in.	Percentage of Absorption in		
				30 min.	4 hours	48 hours
A-I	Clay	3245	898	6.71	12.58	13.29
A-II	Clay	4460	1578	1.21	3.26	5.29
A-III	Clay	3450	730	12.80	16.97	17.36
A-IV	Clay	5010	654	10.68	12.48	13.38
B-I	Clay	3577	504	——	——	18.41
B-II	Clay	5592	706	——	——	16.52
C-I	Clay	2819	746	15.56	15.98	15.98
A-V	Sand-lime	4474	750	5.41	11.29	13.79

The compressive strength recorded in column three is the average of ten individual brick tests for Series A, and the average of five individual brick tests for both Series B and C.

All bricks were laid in portland cement mortar, mixed in the proportion of one part by volume of portland cement to three parts by volume of mortar sand. The mortar joints averaged 0.40 in. in thickness. A different brand of portland cement was used in each series. In Series A, Cow Bay sand, a commercial sand extensively used for mortar and concrete in New York City, was used. The sand for Series B and C was obtained locally from a sand and gravel deposit in Brooklyn, New York. No effort was made to control scientifically the consistency of the mortar; this was left entirely to

TABLE 3
PHYSICAL PROPERTIES OF CONCRETE BRICKS USED IN CONSTRUCTION OF PIERS

Series	Composition of Brick Expressed in Parts of Cement, by Volume	At 30-Day Pier Age		At 90-Day Pier Age		Percentage of Absorption in			Brand of Cement Used in Brick	Remarks
		Compressive Strength, lbs./sq.in.	Modulus of Rupture, lbs./sq.in.	Compressive Strength, lbs./sq.in.	Modulus of Rupture, lbs./sq.in.	30 min.	4 hrs.	48 hrs.		
A-VI	5 of Sand Passing ⅛-in. screen	1383	300	1388	366	6.60	9.14	9.86	X	Cured two days in damp chamber, then stored in air.
A-VII	4 of Sand Passing ⅛ in. Screen	2678	486	2610	467	10.12	11.50	11.83	X	
A-VIII	7 of Sand	1923	524	1892	512	4.12	8.30	9.81	Y	Cured four days in damp chamber, then stored in open air.
A-IX	5 of Sand	2545	630	2529	547	3.54	8.18	9.61	Y	
A-X	5 of Sand, 2½ of Cinders	2462	492	2508	522	3.10	8.19	11.20	Y	
C-II	6 of Sand	1853	437	....	...	5.01	10.47	10.81	Z	Cured four days in damp chamber, then stored in open air.
C-III	4 of Sand	3446	638	....	...	3.35	7.61	9.26	Z	
B-III	Miscellaneous	4704	824	....	...	....	....	8.79	Y	
B-IV		4086	751	....	...	....	....	9.60	Y	
B-V	Mixtures not recorded at request of manufacturer	2544	538	....	...	....	....	10.88	Y	
B-VI		3598	709	....	...	....	....	8.65	Y	
B-VII		2329	530	....	...	....	....	10.83	Y	
B:VIII		1827	377	....	...	....	....	11.78	Y	
B-IX		2737	553	....	...	....	....	9.21	Y	
B-X		2056	471	....	...	....	....	10.27	Y	
B-XI		1500	325	....	...	....	....	12.29	Y	
B-XII		3176	621	....	...	....	....	9.02	Y	
B-XIII		1150	274	....	...	....	....	12.71	Y	

NOTE: All values are the average of five to ten individual tests (10 for Series A, 5 for B and C)

TABLE 9
12-IN. x 12-IN. x 40-IN. CLAY AND SAND-LIME BRICK PIERS. RELATION BETWEEN COMPRESSIVE STRENGTH OF PIER AND (*a*) COMPRESSIVE STRENGTH OF MORTAR; (*b*) COMPRESSIVE STRENGTH OF BRICK; (*c*) TRANSVERSE STRENGTH OF BRICK

Series	Kind of Brick	PIER		BRICKS		Absorption in 48 hrs.	RATIO			Age of Pier
		Average Compressive Strength, lbs./sq.in.	Average Compressive Strength of Mortar, lbs./sq.in.	Average Compressive Strength, lbs./sq.in.	Average Transverse Strength, lbs./sq.in.		(*a*) (1) ÷ (2)	(*b*) (1) ÷ (3)	(*c*) (1) ÷ (4)	
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	
A-I	Clay	1409	1915	3245	898	13.3	0.736	0.434	1.57	30
		1538	2520	3245	898	13.3	0.610	0.474	1.71	90
A-II	Clay	2187	2292	4460	1578	5.3	0.954	0.490	1.39	29
		2473	3473	4460	1578	5.3	0.712	0.554	1.57	90
A-III	Clay	1475	2487	3450	730	17.4	0.593	0.428	2.02	29
		1690	2449	3450	730	17.4	0.690	0.490	2.32	91
A-IV	Clay	1841	2089	5010	654	13.4	0.881	0.367	2.81	29
		2136	2459	5010	654	13.4	0.869	0.426	3.27	90
B-I	Clay	966	1879	3577	504	18.4	0.514	0.270	1.92	26
B-II	Clay	1307	1819	5592	706	16.5	0.719	0.234	1.85	30
C-I	Clay	628	2119	2819	746	16.0	0.296	0.223	0.84	31
A-V	Sand-lime	1794	2441	4474	750	13.8	0.735	0.401	2.39	29
		2034	2412	4474	750	13.8	0.842	0.454	2.71	92
B-III	Mixture of Clay B-I and B-II	1165	1368	4584	605		0.852	0.254	1.93	30

TABLE 10
12-IN. x 12-IN. x 84-IN. CLAY AND SAND-LIME BRICKS. RELATION BETWEEN COMPRESSIVE STRENGTH OF PIER AND (*a*) COMPRESSIVE STRENGTH OF MORTAR; (*b*) COMPRESSIVE STRENGTH OF BRICK; (*c*) TRAVERSE STRENGTH OF BRICK

Series	Kind of Brick	PIER		BRICKS		Absorption in 48 hrs. per cent	RATIO			Age of Pier
		Average Compressive Strength, lbs./sq.in.	Average Compressive Strength of Mortar, lbs./sq.in.	Average Compressive Strength, lbs./sq.in.	Average Transverse Strength, lbs./sq.in.		(*a*) (1) ÷ (2)	(*b*) (1) ÷ (3)	(*c*) (1) ÷ (4)	
		(1)	(2)	(3)	(4)					
A-I	Clay	1255	2698	3245	898	13.3	0.465	0.387	1.40	31
		1421	2998	3245	898	13.3	0.474	0.438	1.58	90
A-II	Clay	1750	2610	4460	1578	5,3	0.670	0.392	1.11	28
		1908	3160	4460	1578	5.3	0.604	0.428	1.21	91
A-III	Clay	1386	2942	3450	730	17.4	0.471	0.402	1.90	28
		1520	2786	3450	730	17.4	0.545	0.441	2.08	92
A-IV	Clay	1597	2007	5010	654	13.4	0.796	0.319	2.44	29
		1984	1643*	5010	654	13.4	1.207?	0.396	3.03	96
A-V	Sand-lime	1810	3137	4474	746	13.8	0.577	0.405	2.43	28
		2157	2298	4474	746	13.8	0.939	0.482	2.89	92

*Defective Specimens.

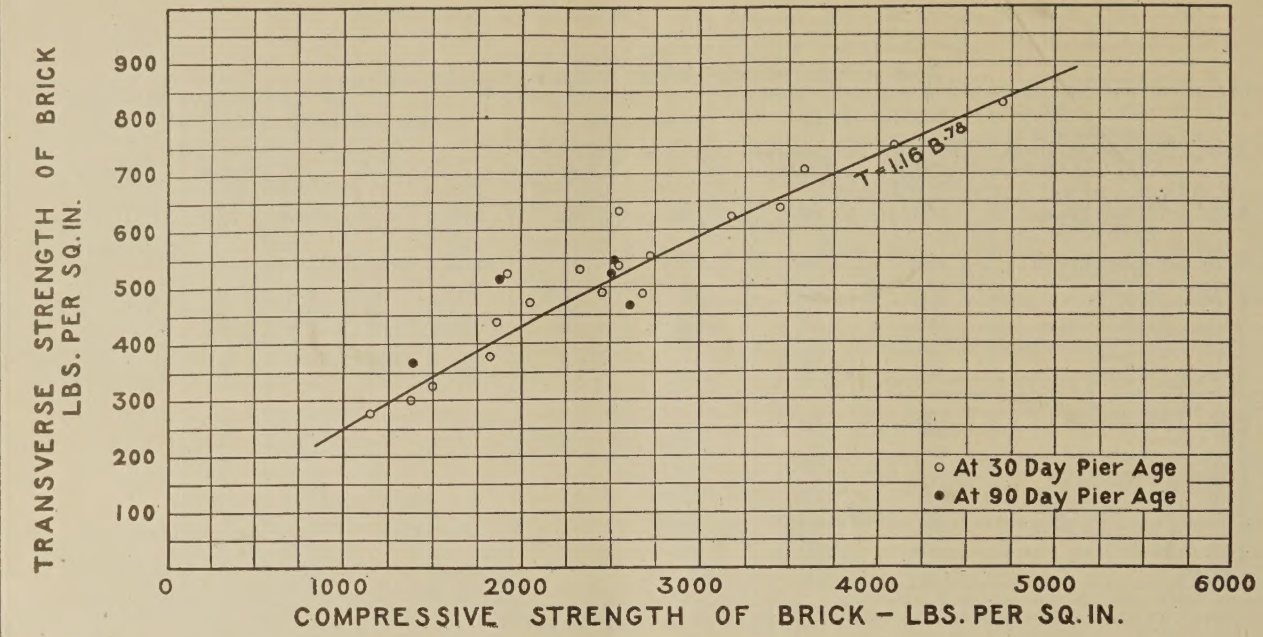


Fig. 2—(Diagram 1 of Report)—Relation Between Transverse Strength and Compressive Strength of Concrete Brick

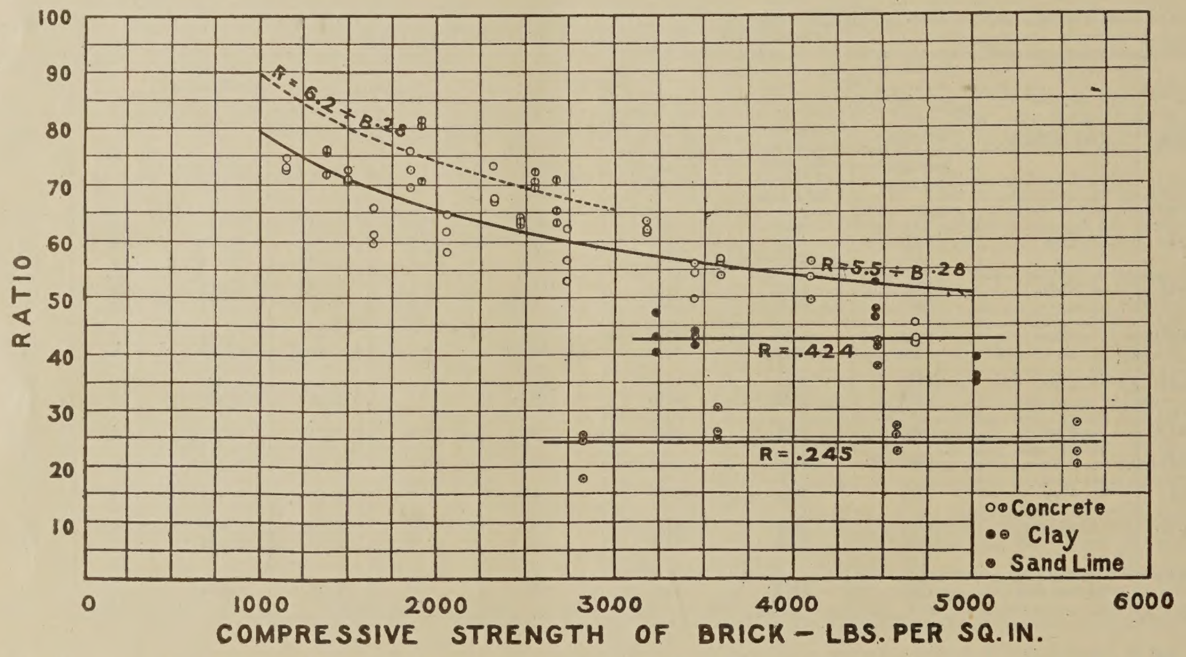


Fig. 3—(Diagram 2 of Report)—Ratio of Compressive Strength of 40-in. Piers to Compressive Strength of Brick (Pier Age 30 Days)

the judgment of the mason, so as to duplicate field practice as nearly as possible. The joints were struck off flush, and no special care was taken to produce other than a good grade of common brick masonry.

All clay bricks were immersed in water previous to being laid in the pier, with the exception of the bricks used in building Pier C-1 of Series C-I, which were laid dry. All concrete and sand-lime bricks were laid dry, that is, without previously wetting the bricks.

Attention is here called to the fact that each series of test piers was built by a different mason. All piers were built and stored indoors under the same conditions, until tested. After construction they were sprinkled daily with water for about one week.

In addition to the brick masonry above described, four monolithic concrete piers were made for comparison with the brick masonry. These were also 12 in. x 12 in. x 40 in. high, and were made of concrete mixed in a batch mixer in the volumetric proportions of one part of portland cement, two and one-half parts of Cow Bay sand and five parts of three-quarter inch crushed lime stone. The consistency of the concrete was such as to produce a slump of 1¼ in. for Piers Nos. 81 and 82 and a slump of 1¾ in. in Piers Nos. 83 and 84 as measured with a 6-in. x 12-in. cylinder. Two cylinders 8 in. in diameter by 16 in. long were made of the concrete used in making each pier. Both piers and cylinders were constructed under the supervision of the Bureau of Buildings and stored indoors under the same conditions as the brick piers.

The compressive strength of the mortar cubes at the end of twenty-eight days is as follows:

Pier Series	Brand of Portland Cement Used in Mortar	Kind of Mortar Sand	Av. Compressive Strength of Mortar at 28 Days, in lbs./sq. in.
A	A	Long Island Cow Bay Sand	2363
B	B	Pit Sand from Brooklyn, N.Y.	1730
C	C	Pit Sand from Brooklyn, N.Y.	2220

(Tables 4 to 8 of the report give the results of compressive tests of the piers and are omitted from this abstract—*Editor.*)

Interpretation of Test Data

The results of the tests made upon individual specimens recorded in the foregoing tables were summarized in order that the average physical properties might be compared.

Tables 9 and 10 summarize the individual tests on the clay and sand-lime 40-in. and 84-in. brick piers, respectively. The average compressive and transverse strengths and per cent absorption in 48 hours of the various clay and sand-lime brick and the average compressive strengths of the corresponding pier and mortar are given in

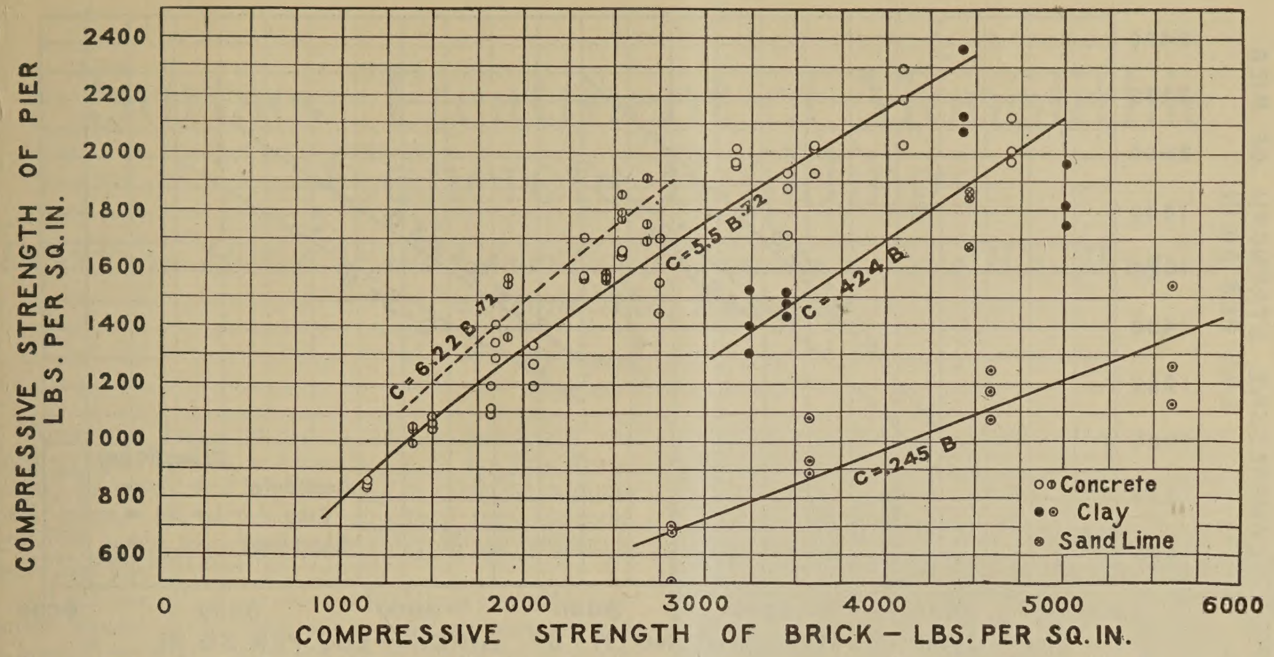


Fig. 4—(Diagram 3 of Report)—Relation Between Compressive Strength of 40-in. Piers and Compressive Strength of Brick (Pier Age 30 Days)

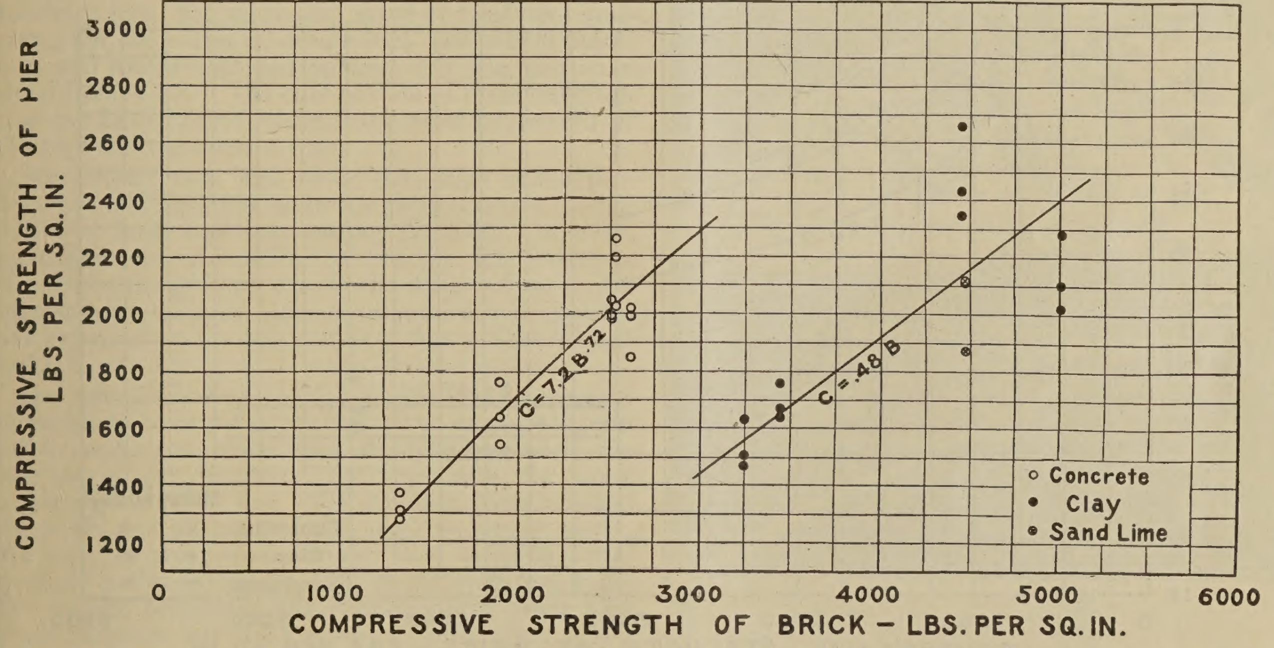


Fig. 5—(Diagram 4 of Report)—Relation Between Compressive Strength of 40-in. Pier and Compressive Strength of Brick at the Age of 90 Days

the first five columns for both 30- and 90-day pier age. Table 9 gives these averages for the 40-in. piers, while Table 10 gives the average for the 84-in. piers. The ratios of compressive strengths of pier to compressive strength of mortar, to compressive strength and to transverse strength of brick, are given in columns six, seven and eight.

Tables 11 and 12 similarly summarize from Tables 3, 6 and 7, the results of tests made upon the 40-in. and 84-in. concrete brick piers.

Relation Between Modulus of Rupture and Ultimate Compressive Strength of Bricks

For clay brick no definite relation between the modulus of rupture and the ultimate compressive strength was found to exist. The highest ratio obtained was 0.354 for brick marked A-II, a down-draft common clay brick, having an ultimate compressive strength of 4460 lbs. per sq. in. and a modulus of rupture of 1578 lbs. per sq. in. Brick marked B-II, a Hudson River common clay brick made by the soft mud process, gave the lowest ratio, namely, 0.126. The ultimate compressive strength of this brick was 5592 lbs. per sq. in. and its modulus of rupture only 706 lbs. per sq. in. The average ratio of the modulus of rupture to compressive strength of the clay and sand-lime bricks was 0.21.

For the concrete bricks a more or less definite relation was found to exist between the modulus of rupture and the ultimate compressive strength as shown graphically upon Diagram 1 (Fig. 2). The equation of this curve is

$$T = 1.16\ B^{0.78}$$

where

T is the modulus of rupture or traverse strength of the brick in lbs. per sq. in. and

B, the ultimate compressive strength of the brick in lbs. per sq. in.

The ratio of modulus of rupture to compressive strength decreases as the compressive strength increases. For an ultimate compressive strength of 1000 lbs. per sq. in. the ratio is 0.25, and this decreases to 0.175 when the compressive strength reaches 5000 lbs. per sq. in.

Ratio of Compressive Strength of Pier to Compressive Strength of Brick

The ratio R of ultimate compressive strength of pier to ultimate compressive strength of brick has been plotted on Diagram 2 for the 40-in. piers tested at the age of 30 days.

Within the scope of this investigation, namely, clay brick having

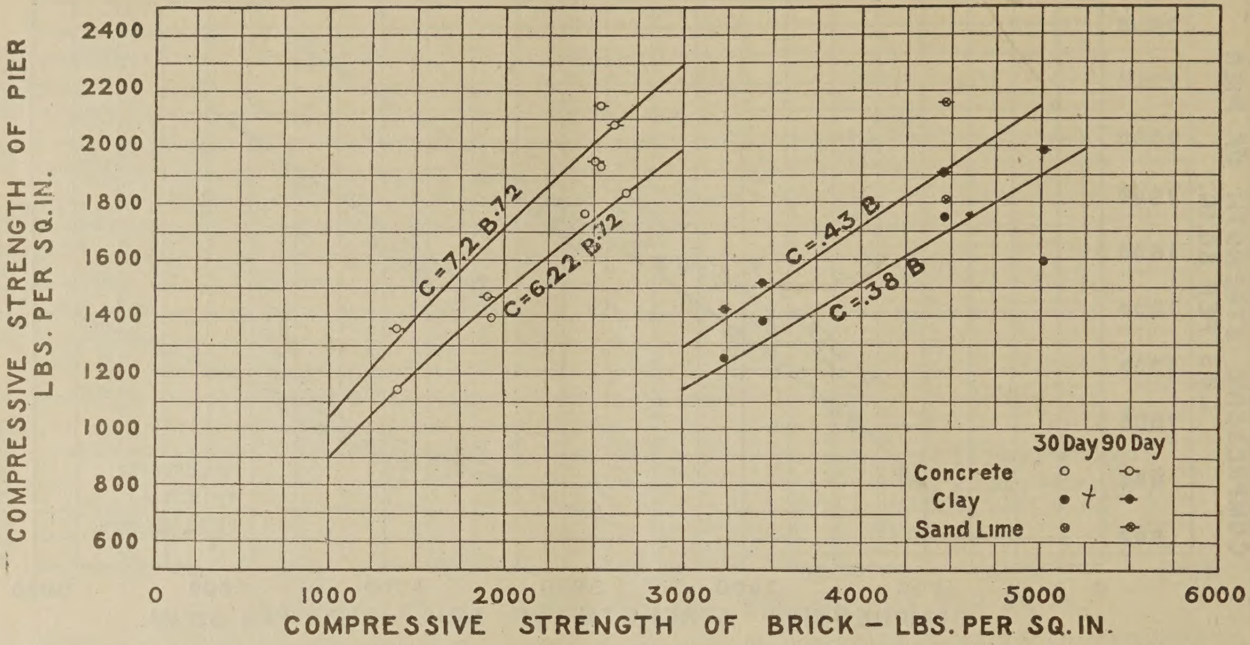


Fig. 6—(Diagram 5 of Report)—Relation Between Compressive Strength of 84-in. Piers and Compressive Strength of Brick at 30 and 90 Days

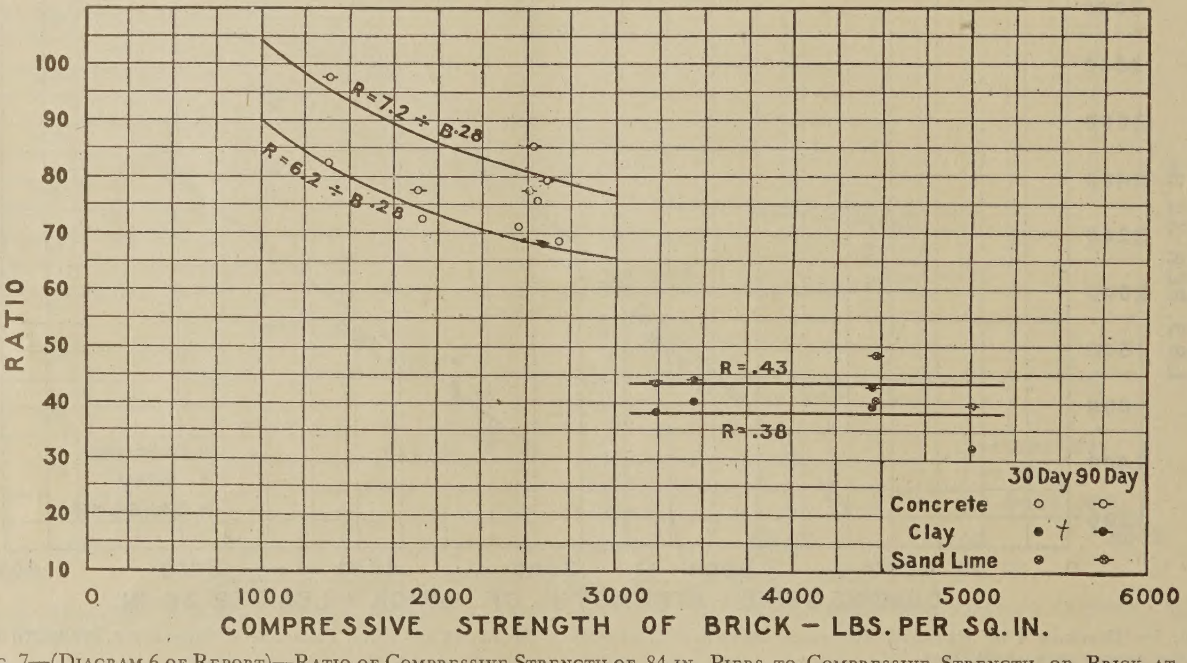


Fig. 7—(Diagram 6 of Report)—Ratio of Compressive Strength of 84-in. Piers to Compressive Strength of Brick at 30 and 90 Days

ultimate compressive strengths ranging from 2819 to 5592 lbs. per sq. in., the ratio R appears to be constant. The upper line of Diagram 2 (Fig. 3), R=0.424, applies to the A clay brick series and the lower line, R=0.245, applies to the B and C clay brick series.

The high ratio obtained for Series A can in part be attributed to the quality of the brick and the high mortar strength as follows:

	Clay Bricks	
	Series A	Series B and C
Ratio of Average Modulus of Rupture to Compressive Strength of Brick	.224	.155
Average Compressive Strength of Mortar, lbs. per sq. in.	2245	1796
Average Ratio of Compressive Strength of Pier to Compressive Strength of Brick	0.424	0.245

For the concrete brick piers the ratio R was found to decrease with an increase in compressive strength of brick, all other variables remaining constant. The numerical value of R expressed in terms of the compressive strength of the brick B is given by the equations:

For concrete brick, Series A

$$R = 6.2 \div B^{0.28}$$

For concrete brick, Series B and C

$$R = 5.5 \div B^{0.28}$$

The first equation applies to concrete brick Series A for which the mortar strength averaged 2336 lbs. per sq. in. and the second one applies to concrete brick Series B and C in which the mortar strength was only 1838 lbs. per sq. in.

For a low-strength brick of the A series, i. e., 1000 lbs. per sq. in., the value of R was found to average 0.89; this decreased to 0.66 for a brick having a compressive strength of 3000 lbs. per sq. in.

The relation that exists between the compressive strength of pier and compressive strength of brick is shown graphically on Diagram 3 (Fig. 4) where all of the results of tests made upon the 40-in. piers at the pier age of 30 days have been plotted.

(Continued on page 195)

Surface Treatment of Monolithic Concrete Buildings

Describing How a White Cement and Granite Surface Was Produced on a Monolithic Building

By Robert F. Havlik
Engineer, Mooseheart, Illinois

When the Loyal Order of Moose purchased the property now known as Mooseheart, on the Fox River, about 40 miles west of Chicago, to establish a home and school for dependent children, they selected concrete as the principal material for all the important buildings that were to be erected.

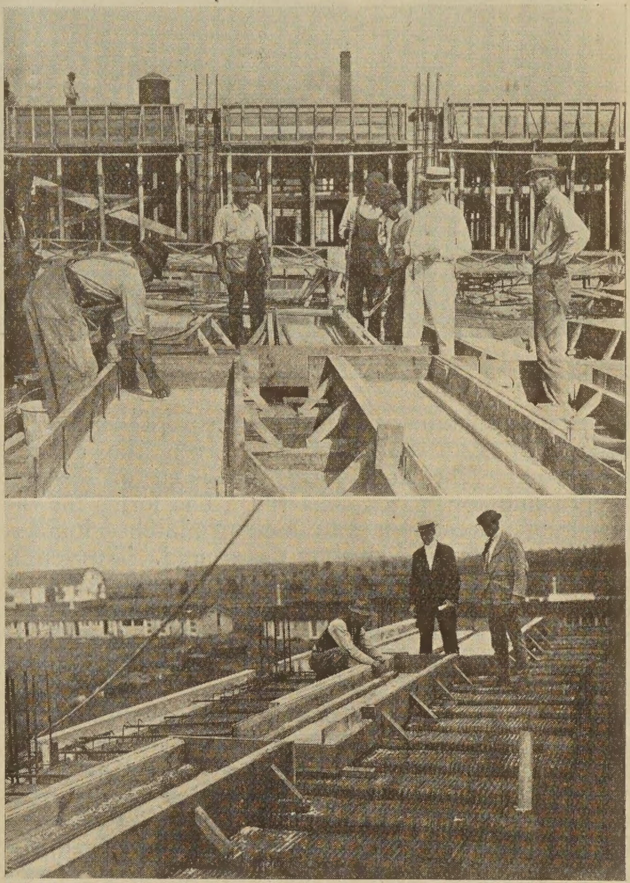
All but one of our permanent buildings are of Hydrostone blocks, faced with white portland cement and Crown Point spar. All floors are of reinforced concrete including the attic floor, and the floors of all the buildings have a finished surface of terrazzo. The industrial buildings have flat roofs, also made of reinforced concrete, but the cottages, dormitories, and school buildings are roofed with red Spanish clay tile, laid on a wood framework. The only portion of these buildings that can be destroyed by fire is the wood framework of the roof and the interior trim.

Mooseheart now has about fifty high grade permanent buildings, ranging in size from cottages costing $7,000 to large buildings costing $250,000. The ever-increasing cost of building construction has forced us to exercise the greatest care in the design of our buildings, in order to build them as economically as possible and yet maintain the high standard that was established in 1914.

Our officials, delegates, and members have become so enthused over the superior quality of our concrete blocks and trim stone that we even veneered the exterior of our industrial buildings with the same material. In 1920 and 1921 building costs reached the peak, and all construction work was very costly. We were in great need of additional buildings, particularly a three-story building of the industrial type. We wanted something that would match other high grade buildings but of a less costly construction. As a result, we conceived the idea that this result could be obtained by omitting the regular veneer of concrete building blocks and facing the monolithic columns, spandrels, and curtain walls with white portland cement and Crown Point spar like the granite surface of our regular blocks.

A three-story building, 49 ft. 6 in. wide and 149 ft. 6 in. long, was designed originally to house six different shops for Mooseheart students—two on each floor, but on account of the shortage of dormitory space part of the building is being used temporarily for dormitory purposes. It has one row of columns through the center, and one row of columns all around the building on approximately 16-ft. centers. The facing of the outside columns is 1 in. thick of a mix of white portland cement and Crown Point spar, as are also the curtain walls from the floor to the window sills. The spandrels have a veneer 1¼ in. thick, of the same material.

After the foundation was poured to grade, the forms for the inside columns and the floor above were set in place, and also the inside portions of the forms for



Figs. 1 and 2—Placing Facing, or Veneer Concrete, in Front Sections of Column Forms

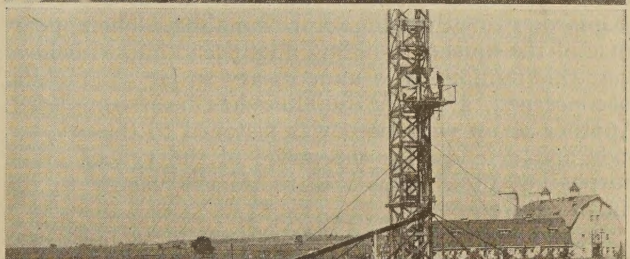


Fig. 3—Pouring Floors with General View of Operations

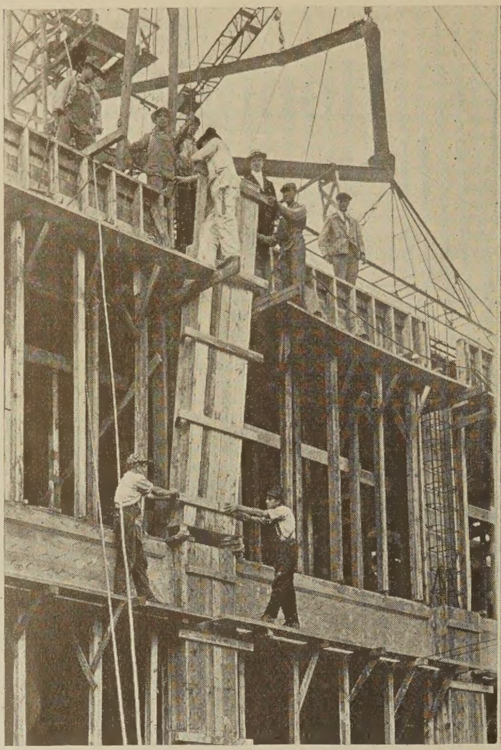


Fig. 4—(Left) Front Sections of Exterior Column Forms with Hardened Concrete Facing, or Veneer Being Put in Place

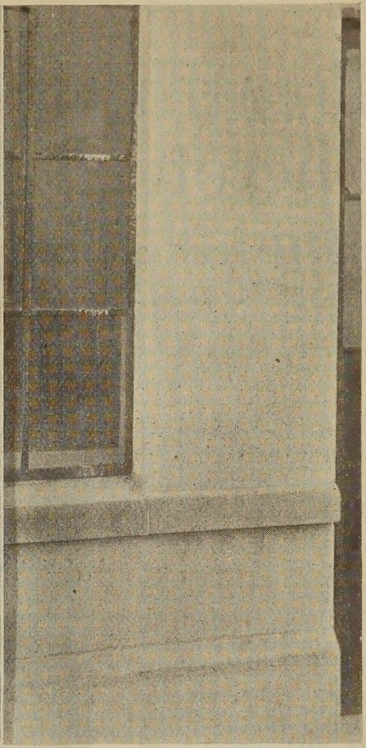


Fig. 5 — (Right) The Results of the Surface Finishing (See Text)

the exterior columns. The floor forms were then set in place and also the reinforcing—even the column reinforcing. The floor forms consisted of General Fireproofing corrugated steel tile. The forms for the outside of the columns were built of matched lumber, and were set flat and level on the ground. The veneer mix, 1 in. thick, was cast in these forms and allowed to harden to permit handling without damaging the concrete (Figs. 1 and 2).

Wire ties on 4-in. centers and staggered, were used to tie the veneering to the wooden forms. Spikes, small bolts, or pieces of wood were placed through the loops of these wires and twisted until the wire was tight. The twisting, of course, was done after the veneering had hardened. Quarter-inch round rods were placed as shown in the illustration on 2-ft. centers. These rods were used to prevent vertical cracks in the veneer and also to stiffen the veneering in the forms to guard against breakage from handling. The appearance of the finished building might lead one to believe that this reinforcing is unnecessary so far as cracking is concerned, after the building has been completed. Another set of wire loops was fastened to these ¼-in. rods and extended to the inside of the veneer. The purpose of these loops was to tie the veneer to the rough concrete.

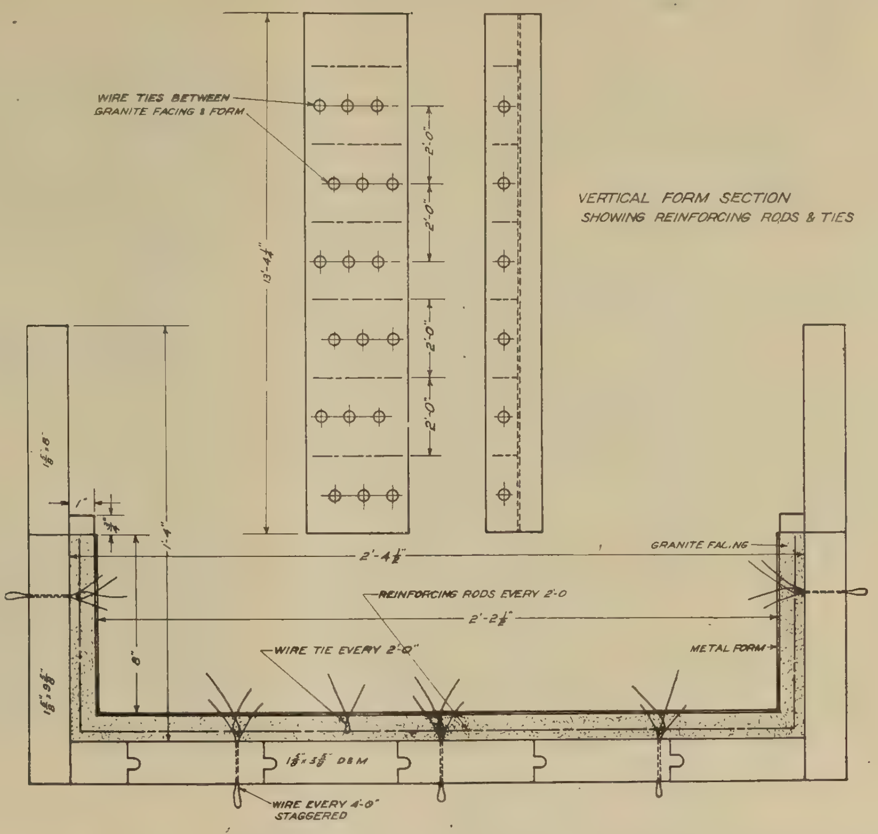
Figs. 1 and 2 indicate that a sheet metal form was used to form up the inside of this veneer, but it was found that such a form was impracticable and too expensive. The mixture for the veneer was placed on the bottom of the form, struck off, and tamped to 1-in. thickness. A form of wood was then set to form up the sides of the veneer. The sides of this thin veneer were then cast in place. This operation followed immediately after the placing of the facing in the bottom of the form, so that the sides and face bonded together to form one monolithic mass. This veneering was kept wet constantly for about four days, after which the forms were moved to the building and set in place with a derrick, as shown in an illustration. The columns and floor slab for one story were then poured as soon as possible after the outside forms of the columns and veneering were set in place. Great care was taken to prevent the veneering from drying out. The veneering for the columns of the second story was cast in a similar manner, excepting that in this case the forms were set up on the second floor of the building. The same process was repeated for the third story.

After the forms were removed from the building, the veneer was scrubbed as thoroughly as possible with full strength muriatic acid until the facing aggregate was exposed. The acid was then washed off thoroughly with clean water. The wire ties that held the veneering to the forms were cut off slightly below the surface of the concrete, and the damaged spots were repaired with a mix identical with that of the facing.

The surface of the spandrels was first cast in the rough concrete, with liberal use of ties to hold the veneer. The veneer for these spandrels was cast in place after the forms were removed from the building. In this case, the forms for the veneer were removed the day after the veneer was poured and the surface of the veneer was scrubbed immediately with water to expose the surface of the aggregate.

The concrete ornaments shown near the top of the columns, and also the ornament over the main entrance of the building, were precast in our concrete products plant, and set up in the forms before the rough concrete was poured. We worried a great deal about the bond between the veneer and the rough concrete, but were agreeably surprised to discover that our worries were uncalled for. Two of the column forms bulged slightly and we deemed it necessary to knock off the veneer and re-surface that portion of the columns. In doing this work we discovered that the bond between the veneer and the rough concrete was so strong that when we attempted to chisel the veneer away from the rough concrete the latter broke off with the veneer—the breaks frequently coming in the center of pieces of aggregate. This indicates that the wire ties were unnecessary.

The sills used in the building were precast in our



Vertical Form Section Showing Reinforcing Rods and Ties. Wire Ties Between Granite Facing and Forms

WIRE TIES BETWEEN GRANITE FACING & FORM
13'-4¼"
2'-0"
2'-0"
2'-0"
2'-0"
VERTICAL FORM SECTION SHOWING REINFORCING RODS & TIES
1⅝"×8"
1"
¾"
1'-4"
2'-4½"
GRANITE FACING
REINFORCING RODS EVERY 2'-0
2'-2½"
8"
WIRE TIE EVERY 2'-0"
METAL FORM
1⅝"×9⅝"
1⅝"×3⅝" D&M
WIRE EVERY 4'-0" STAGGERED

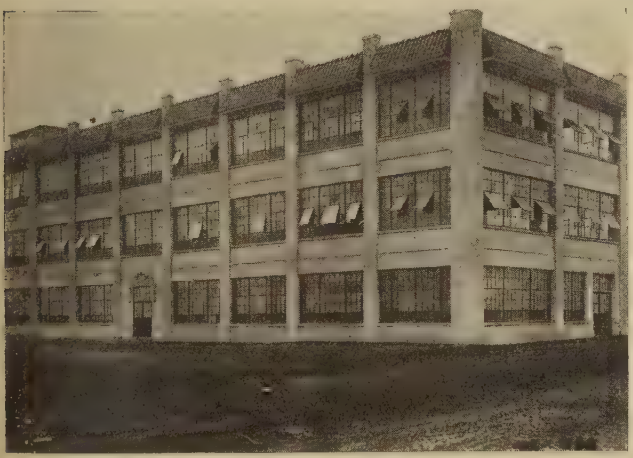


Fig. 6—The Completed Building

concrete products plant. An accompanying illustration shows how well the surface of the veneer of the building matched these precast sills. When this work was about finished, we experimented a little with one column by placing a layer of glossy black building paper on our forms. We found that this method practically eliminated the seams which appeared in the other columns from the joints in the form lumber. Were we to use this method in another building, we would undoubtedly use this glossy paper on all our column forms before casting the veneer. We would have preferred to bush-hammer the entire surface of the columns instead of washing it with acid, but we were not equipped to do so. This undoubtedly makes a better job than the acid treatment. From a standpoint of economy we found that this method cost us but little more than plain concrete would have cost with the usual care in finishing and the finished surface is as good as that of our precast blocks, except that the effect is monolithic rather than ashlar.

For industrial buildings, wherever surface appearance is of more than usual consequence, this method of construction will produce very pleasing effects in harmony with the surroundings, and the cost will be far less than if veneering is used, of brick, stone, or concrete building blocks. This method of surfacing a large building is a culmination of successful experiments that we have made in casting large arches in concrete block buildings right in place, and facing them with white portland cement and Crown Point spar. In such cases, we have removed the forms the same day the casting was done, and sprayed or scrubbed the surface with water to expose the aggregate. A day or two later we cut false joints in the surface of the arch to match up with the jointing of the adjoining blocks.

Bamboo as a Reinforcing for Concrete

Bamboo which has been chemically treated is used as a reinforcing for concrete in Japan and according to Henry C. Hitchcock, the American consul, Nagasaki, Japan, the chemicals used in treating the bamboo are apparently known only to the few who have made use of them.

Bamboo is occasionally used without any chemicals to protect it from decay, in the construction of concrete ditches, small culverts and the like in districts where there is a great deal of sulfur in the soil and sulfur gas in the air, for the reasons that it is believed that bamboo is not so quickly destroyed by the sulfur as ordinary reinforcing would be.

A Cinder Block and Stucco House for Less Money

The completed house shown in the upper of the two accompanying illustrations is in a suburb of Philadelphia. The owner of the house had it designed originally for construction with hollow clay tile and stucco. The cost on the job went higher in the estimate than the amount of money he was prepared to put into the enterprise. He insisted upon not overstepping a cost dead-line, beyond which he had resolved not to go; so when the figures came in, he appealed to the contractor to show him how he could build the same house—for he was unwilling to sacrifice any of the essential features of the plan, which is also shown herewith—under the figures of the original estimate. The contractor came back after a few days with the suggestion that the house be built of cinder concrete block, which is being used extensively in the Philadelphia market. He pointed out that in addition to saving on the cost, it would provide larger bearing surfaces and therefore more solidity in the wall itself. The savings directly traceable to the change of the wall material were, on a unit basis, as follows:

1. A saving due to lower material cost of approximately 1c per square foot.
2. A saving due to ease in handling and laying of 2½c per square foot.
3. A saving, due to the reduction of the sub-bid for the same quality portland cement stucco, of 10c per square yard. The sub-contractor explained that this reduction was due to the fact that cinder block, being more uniform, required less stucco material and less labor for the same character stucco surface.
4. A saving of 2c per square foot in the charge for interior plastering, due to the ease with which furring strips may be nailed directly to the block, thus doing away with the expensive wall-plugging otherwise required.
5. A saving of 50¢ per lineal foot in the construction of the pent eaves and porch roofs, due to the ease with which the bearing strips for the porch-roof rafters may be spiked directly to the wall, thus doing away with the expensive through-bolting necessary to carry these strips in other forms of masonry wall construction.
6. A saving in labor required to set window and door frames, credited to the owner at 25¢ per opening. Due to the stability and uniformity of a cinder block wall, the builder actually saves one hour of carpenter labor on each opening, or a saving should have been credited here of $1.00 each.
7. In the setting of floor joist, a saving of $5.00 per floor, due to the elimination of any shimming under joists. The block was cut in place to allow all joists to

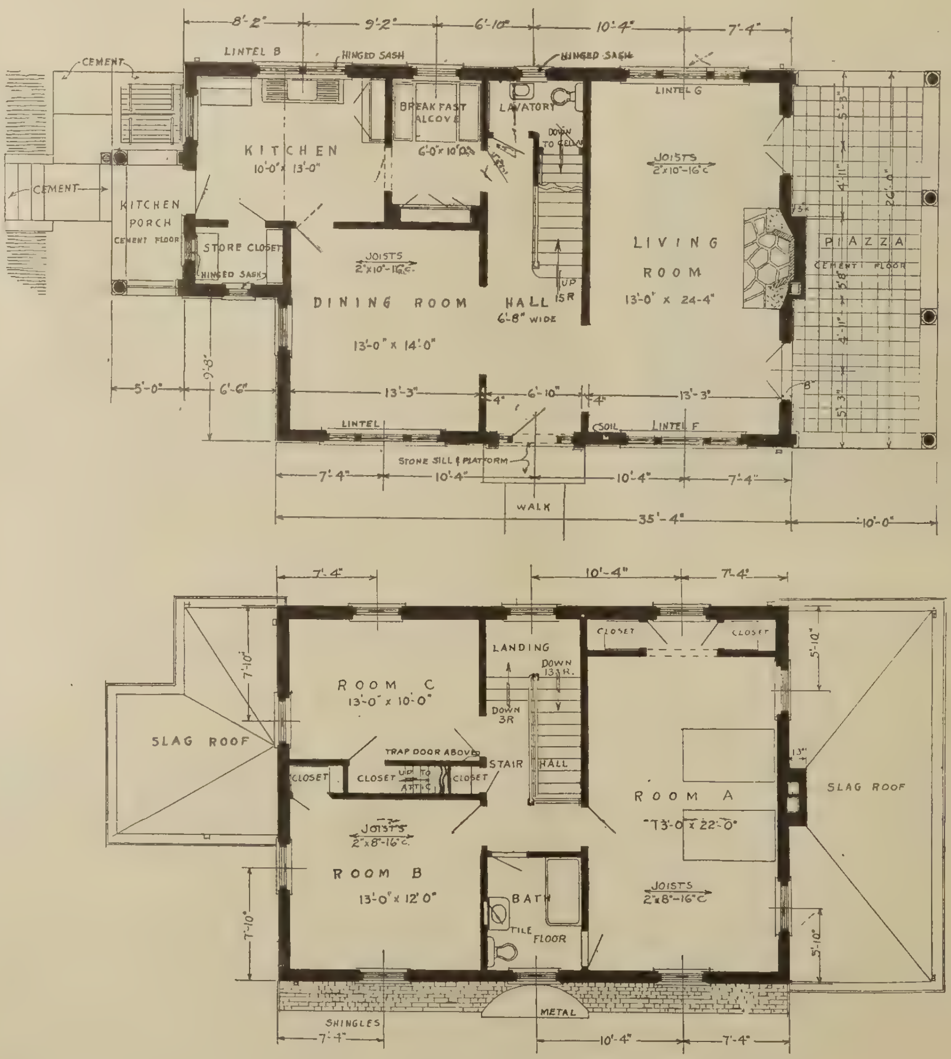


FIG. 3—FLOOR PLANS OF CINDER BLOCK HOUSE ON WHICH SAVINGS WERE MADE — EDWIN A. YEO, ARCHITECT, PHILADELPHIA

Fig. 1—A Cinder Block House in a Philadelphia Suburb, on Which Construction Economies Were Made

Fig. 2—A Similar Cinder Block House Under Construction

set at the proper level. The builder's actual saving here was in the neighborhood of one carpenter-day, or at the rate of $10.00 per floor. A total reduction was made, due to the above items, of some $200 on a revised contract price of $11,900.00.

The second illustration shown is of a cinder block house of similar design to that mentioned above, in process of construction.

Diagonal Reinforcement Sometimes Desirable in Concrete Slabs

It would be natural to suppose that the most effective way of using steel for reinforcing concrete floors and other slabs would be to place it in the direction in which the stress was applied, and at right angles to the direction of probable cracks. Mathematical analysis of the problem confirms this assumption.

In the design of concrete ships, however, there were other considerations which made it seem desirable to place the steel diagonally with respect to the direction in which the cracks were expected. Accordingly tests were made at the Bureau of Standards on slabs in which different types of reinforcement were used. These tests confirm, in a general way, the correctness of the mathematical analysis and show that the reinforcement should be laid parallel with the span and not at an angle with it; unless there are other factors, such as shrinkage in setting or expansion and contraction with change in temperature, which tend to produce cracks at right angles to those due to load stress.

But shrinkage and expansion occur in all concrete structures and frequently transverse reinforcement is required. Cracks from such causes may be prevented by the use of bars laid at an angle with the span, or by mat reinforcement.

In these tests it was found that the use of reinforcement having diamond shaped meshes distributed the cracks effectively and kept them smaller than was the case with the other types of reinforcement tested. About a 12-in. lap where the ends of these sheets of expanded metal joined was found necessary to prevent slipping of these splices.

The early close of the war rendered it unnecessary to apply the results of these tests to concrete ships; but the information acquired is likely to be of value in the design of buildings.

The results of these tests are published in Technologic Paper No. 233 of the Bureau of Standards, entitled "Tests of Heavily Reinforced Concrete Slab Beams: Effect of Direction of Reinforcement on Strength and Deformation." Copies of this paper can be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C. The price is 15c.

Highway Culvert Forms Standardized

By George C. Habicht

On road contracts of considerable length, there usually are a number of culverts of similar size, varying only in length, the construction of which is usually carried on in a hit or miss manner, very little attention being paid to the detail of form work.

The erection and removal of the necessary forms, owing to the small size of these culverts, is usually an expensive operation when considered in relation to the amount of concrete involved. The reduction of this expense that can be effected by designing forms that can be easily erected and removed will pay for the time spent in so doing many times over.

Last summer, the writer was employed as engineer by a contractor on a New York State highway contract, eight miles in length, on which there were about 40 culverts, ranging in size from 2 ft. x 2 ft. to 5 ft. x 5 ft.

A set of form designs was prepared by the writer for each of the following sizes, 2 ft. x 2 ft., 3 ft. x 3 ft., 4 ft. x 4 ft., and 5 ft. x 5 ft., and a bill of material made up for the longest culverts of each of the several sizes. By combining parts of these sets, we were enabled to use them for the 2 ft. x 3 ft., 3 ft. x 4 ft., and 4 ft. x 5 ft. culverts.

The forms were built by a gang of five carpenters in advance of their need, each piece being given a mark; a schedule was prepared for all culverts showing number of pieces of each mark required for each culvert, and a record kept of their use. About 300 or 400 small wedges, about 4 in. long and 1 in. wide, also a quantity of 10-in. and 14-in. spreaders, were made at this time and bagged in empty cement bags to await their use.

Our usual practice was to erect forms on the day following the concreting of the foundation, and, taking a 4-ft. x 4-ft. culvert for example, our procedure was as follows:

First—a ⅞-in. lining piece was nailed to the foundation as indicated on the assembly drawing, then the side panels MK-P-4 were lined up to this for line and grade and temporarily held in position by cleats across the top. Bottom walers were then placed, struts marked S-4-B placed between them and lightly

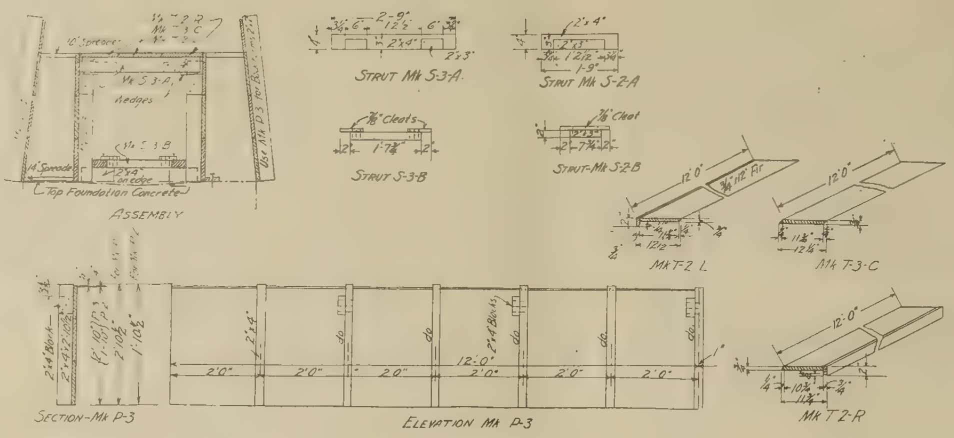


FIG. 1—STANDARD FORM FOR 2-FT. x 2-FT. AND 3-FT. x 3-FT. CULVERTS

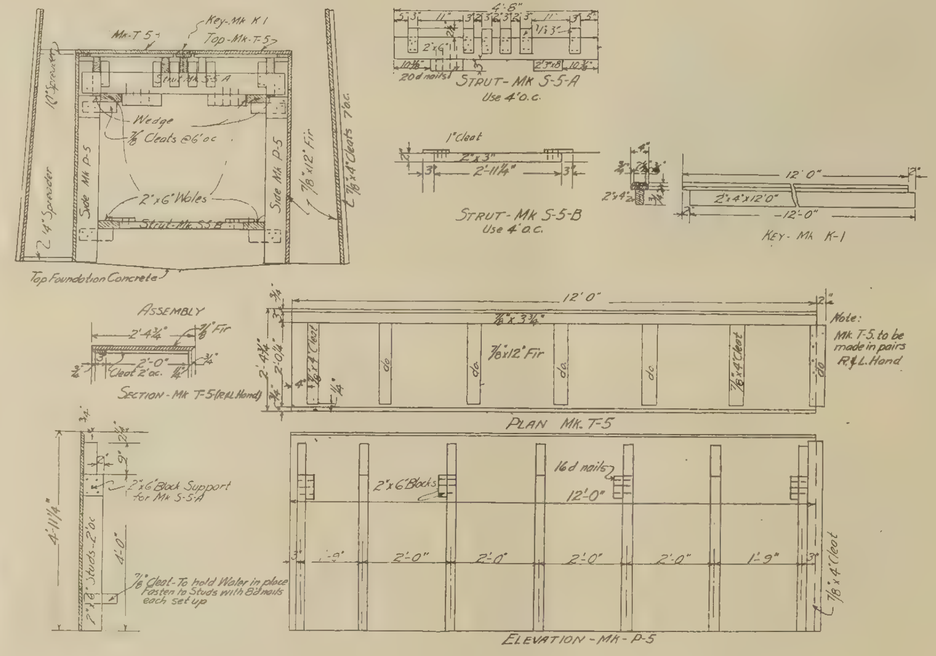


FIG. 2—STANDARD FORM FOR 5-FT. x 5-FT. CULVERT

nailed to walers. Top walers were then placed and top struts marked S-4-A wedged in position and tacked in place. The loose 2-in. x 4-in. stringers were placed next, then the key piece marked K-1 and finally the top panels marked T-4. The 10-in. and 14-in. spreaders were placed and panels marked P-5 (front panels of 5-ft. x 5-ft. culvert) used as back forms for 4-ft. x 4-ft. culverts. The back forms were then braced, parapet and wing forms built, and forms poured.

Removal of the forms was a very simple operation: the wedges at the top strut S-4-A between strut and waler were first knocked out permitting removal of walers, wedges holding struts to grade were then released, struts lowered, longitudinal stringers and key piece K-1 pulled out, top and bottom struts and bottom walers removed, side panels P-4 pried out at the bottom and removed and the slab panels T-4, which invariably adhered to the slab concrete, lowered and removed. Wedges were picked up, also the 10-in. and 14-in. spreaders, and rebagged and forms neatly piled according to their marks, all ready for the next culvert.

It cost us 11c per sq. ft. to build the forms, inclusive of material. The cost of erecting them throughout the entire job averaged 4c per sq. ft., while the average cost of removing the forms was less than 1c per sq. ft. Some of the forms were used seven and eight times, the 5-ft. x 5-ft. forms also being used as runways in the concreting of a bridge and as slab forms for another bridge.

Had the old method of building forms for each culvert in place been pursued, there is no question that at least twice the amount of lumber would have been required and the labor cost trebled.

In the manufacture of concrete common brick it is generally considered that 1000 brick require 2 barrels of cement and 1½ yards of aggregate. It is conservative to estimate that one man will be able to produce from 4 to 10,000 brick per day, depending on the type of power equipment installed. The margin of profit in the manufacture of concrete face brick is generally larger than in concrete commons. This is strikingly true of the more elaborate type of brick such as the tapestry and oriental brick. In concrete brick manufacture production counts. It is doubtful if concrete brick manufacture is a thing to undertake in a small way.

The Gypsum Industries, a bureau of research, promotion and publicity has announced that on and after May 1 its offices will be in the America Fore Building, 844 No. Rush St., Chicago. Virgil G. Marani is chief engineer, Professor George A. Olson, agricultural director and W. J. Fitzgerald is traffic manager of the organization.

Morgan Park Church of Concrete Block

By A. J. R. Curtis

All who have faith in the destiny and ultimate achievements of concrete masonry will find rare inspiration in the new Protestant Church at Morgan Park, Duluth. It may be stated modestly that the writer has journeyed from Halifax to the Pacific searching for the worthy in precast concrete construction; certainly the concrete block church at Morgan Park is one of the finest examples. Its beauty springs from its simple lines, the softness of texture, and the warm, friendly color tones of its concrete ashlar walls.

The pictures fail to show the pleasing color values of the structure or the delightfully changing play of light and shadow across these surfaces following the travel of the sun. The interior is quite as pleasing as the exterior, being also surfaced with concrete, although in small block of uniform size, resembling large brick. Partition walls and roof covering are also of precast concrete while the floors and stairs are of reinforced construction.

The general plan of the edifice is in the shape of a modified passion cross with some additions. In extreme length it is 113 ft. 10 in. with a width of 45 ft. 4 in. for the main body of the structure and an extreme width of 72 ft. 3 in. The dominating structural detail is the buttressed Gothic tower, 22 ft. square, rising to a height of 73 ft. 4 in. above grade. It is a beautiful example of period architecture faithfully reproduced in a material ideally adapted for the purpose. The design is also to be noted for the graceful buttressing throughout, the tower parapet and the delicate ornamentation carried around the forward wings at the roof line.

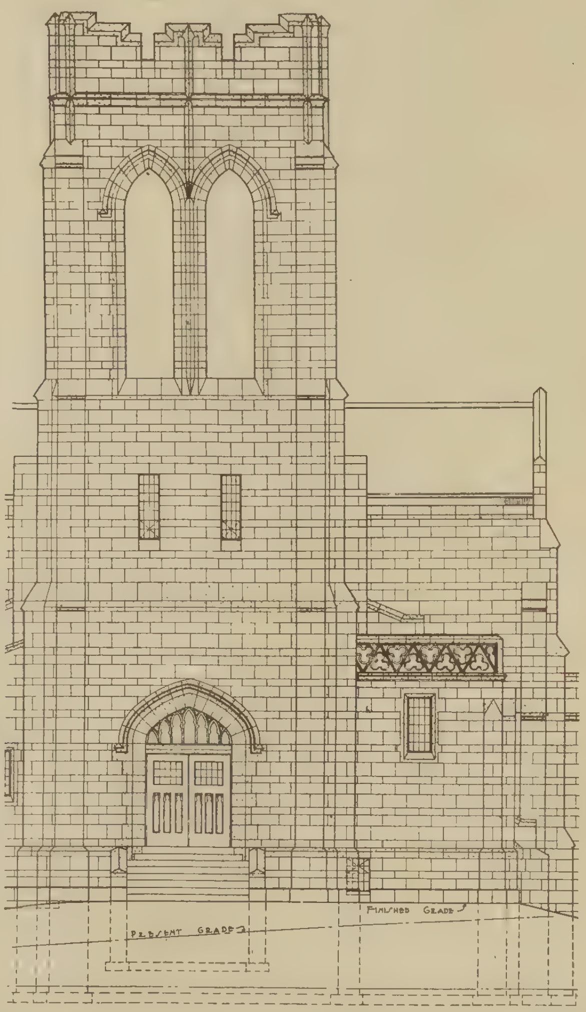


Fig. 3—Part Elevation Showing Arrangement of Concrete Units

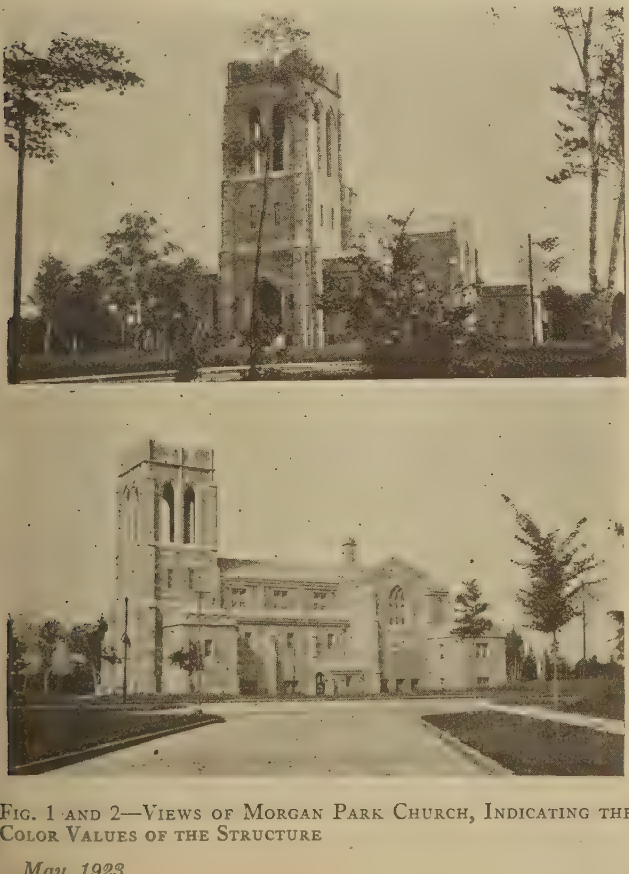


Fig. 1 and 2—Views of Morgan Park Church, Indicating the Color Values of the Structure

The footings and foundations were constructed entirely of monolithic concrete, as were the interior bearing walls and partition walls below the first floor. The main foundation walls are 18 in. in width, widening to 26 in. under the buttresses and 27 in. under the tower. Four interior columns 21 in. x 36 in. and two columns 21 in. x 50 in. provide center bearings for the concrete floors and some of the block work above.

So far as concrete masonry is concerned, the wall details are original, and at all typical wall sections form what may be considered triple walls with a combined thickness of 17 in. An accompanying illustration shows the typical detail quite clearly. The exterior

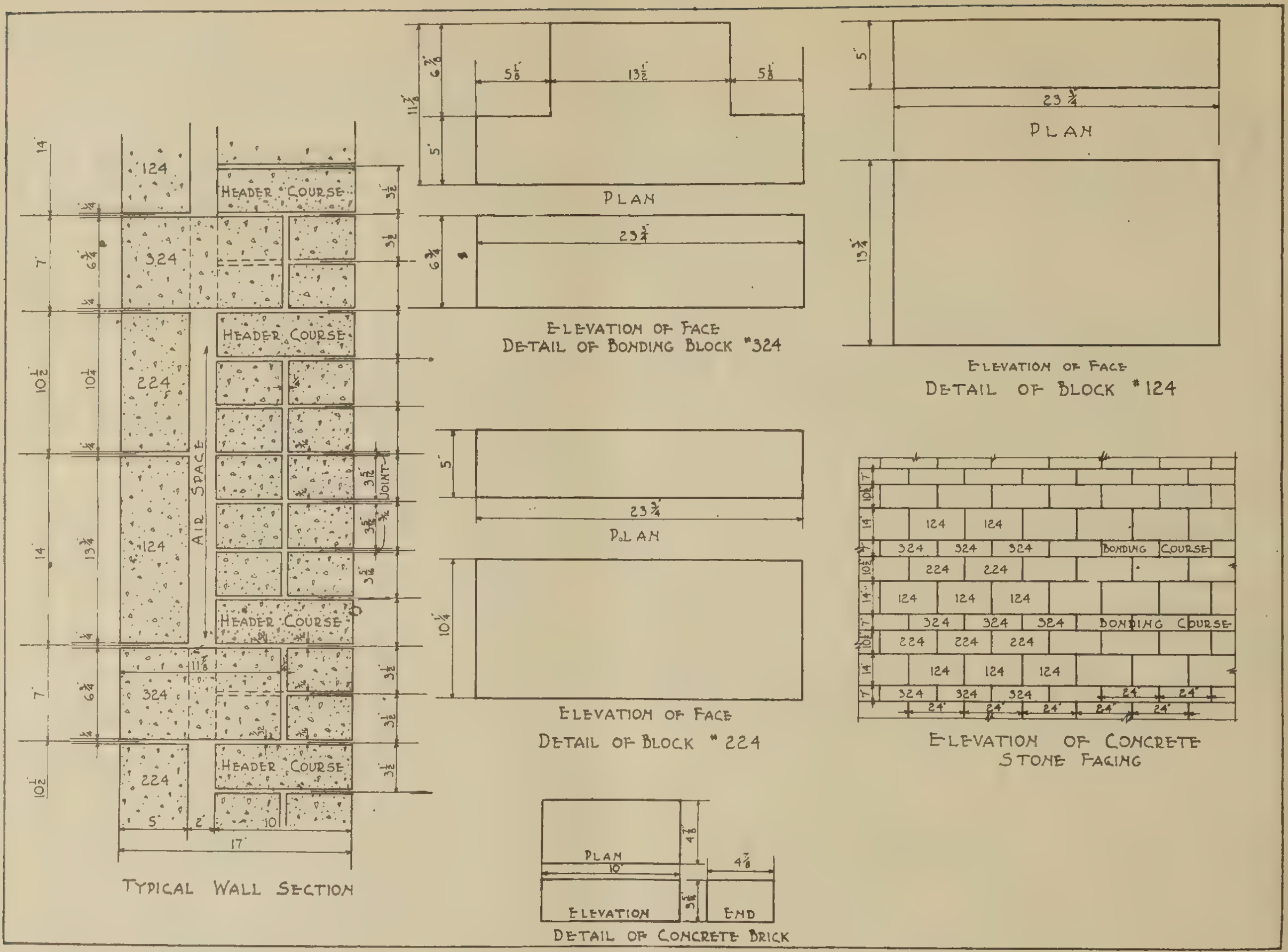


Fig. 4—Typical Details Showing Units and How They are Arranged

block of masonry consists for the greater part, of three sizes, designated as numbers 124, 224 and 324. These three varieties have heights 13¾ in., 10¼ in. and 6¾ in., respectively, so that when laid in ¼-in. joints they produce courses of three heights—14 in., 10½ in. and 7 in. These courses were revolved as the walls went up, each course varying in height from that next to it. The 14-in. and the 10½-in. courses consist of block laying 24 in. long in the wall with a thickness of 5 in., forming no header bond; the 7-in. courses are made up of block 24 in. long and 5 in. wide with a projecting header 6⅞ in. long which forms a bond with the interior masonry.

The double interior walls are formed by block or large brick of which the regulars are 3$\frac{5}{16}$ in. high (setting 3½ in. in the wall), 4⅞ in. wide and 10 in. long. The method of laying these brick is best understood by referring to the illustration showing typical wall section. No plaster was used on the walls of the main auditorium, the inner wall of concrete units being exposed.

All of the outside block, concrete architectural trim and the interior block were cast in carefully prepared wooden molds, using a mixture of one part portland cement, two parts pit sand and two and one-half parts screened gravel ranging from ¼ in. to ½ in. No coloring matter of any kind was used in any of these units except the small block or brick exposed on the inside. The ordinary block used throughout the exterior face of the building were cast face upward in the molds so that the finished texture would be rather rough. These surfaces were given no brushing or tooled finish of any kind.

Architectural trim block, such as used for buttress caps, parapet details, copings, window tracery and door and other openings, were cast with the face of the block next to the mold, in order to obtain a smooth finish. The pleasing contrast in surface texture between block and trim obtained by the simple device is almost unbelievable. Further irregularities in the surface tones were obtained by slightly varying the curing conditions for individual pieces.

The concrete block or brick used in the interior are most interesting. They were also cast in wooden molds with a primary mixture, used for all of these units which are not exposed, consisting of one part portland cement to two parts pit sand and two parts gravel ranging from ¼ in. to ½ in. The exposed interior brick were cast face up in the mold. The facing, which was applied to a depth of about ¼ in., was made by the following formula: 1 part portland cement, 2½ parts screened and washed lake sand, 1/6 part hydrated lime and 1/12 part yellow ochre. This facing was not trowelled or finished in any way, but was allowed to harden just as it flowed into the molds, producing a very pleasing rough texture.

Mortar used in laying up the exterior block and architectural trim was composed of 1 part portland cement to 2 parts screened sand and 1/10 part hydrated lime. Mortar used in laying the small interior units was composed of 1 part portland cement, 2 parts screened sand, 1/10 part hydrated lime and 1/12 part yellow ochre. These mortars harmonize splendidly with the surrounding concrete.

Floors throughout the church, as well as stairways and landings, are of reinforced concrete construction. In the main auditorium the floors are polished and surfaced in red, being squared off so perfectly as almost to simulate tiles. Massive roof timbers help to carry out the substantial and dignified tone given to the interior by the exposed concrete. The roof covering of green concrete roofing tile contributes a touch of contrast.

The time consumed in completing the Morgan Park Protestant Church was approximately 11 months.

The designer, M. N. Willis, Duluth, is architect of the Oliver Iron Mining Co. John Davidson, general manager of the Morgan Park Co., had under his supervision all of the concrete units (including roofing tile). Messrs. Willis and Davidson have both expressed themselves as well pleased with results obtained in concrete and the building has already come to be loved and admired by the thousands of steel and cement workers who live in the surrounding community.

Precast Concrete Piles

By Paul Kircher
Massey Concrete Products Corporation

Practical experience outweighs theoretical considerations in the solution of foundation problems. The character of the soil on which a structure is to rest determines the type of foundation best suited for use. Borings, soil pressure experiments, or test piles furnish the information on which a man trained in work of this sort can base his decisions as to the correct solution of the problem.

The importance of a properly designed foundation cannot be over-emphasized. Many a building has failed or required extensive repairs, not because of any inherent weakness in its design or construction, but because of insecure footings. More than one bridge has had to be replaced before its allotted time because the abutments or piers on which it rested had not been properly designed.

No one type of construction will meet all conditions, but precast concrete piles are proving their economy and adaptability in an ever-widening field. Of the many possible types of foundation, concrete piles are one of the surest and most fool-proof, which accounts largely for the general adoption of this form of construction for such work as railroad trestles, permanent bridge footings, and other structures where permanence, high bearing power and exceptional safety are among the requisites.

Many instances of special applications of concrete piles could be cited. In San Francisco harbor, piles up to 120 ft. in length have been driven for dock construction. Concrete piles are particularly suited for this special use, not only because they can be manufactured in any desired length, but also because they are such a permanent form of construction.

An instance in which the use of concrete piles would have been a good investment in building foundation work, and in which it was later necessary to actually make use of them, is found in the case of an Eastern railroad that located a new coal thawing shed on a cinder fill. At first it was thought that treated wooden piles would answer the purpose and the building was built on such a foundation. The heating pipes ignited the cinder fill and before long, the foundation piling had been partially consumed by the fire so that it was necessary to rebuild the entire structure.

DESIGN AND MANUFACTURE

The design of concrete piles is usually based on the method of handling to be used prior to driving. When a pile is to be handled with a single sling, its section at the point of pick-up must, of course, be able to resist the bending due to its own weight plus impact due to jarring. The same is true when two or more slings are used.

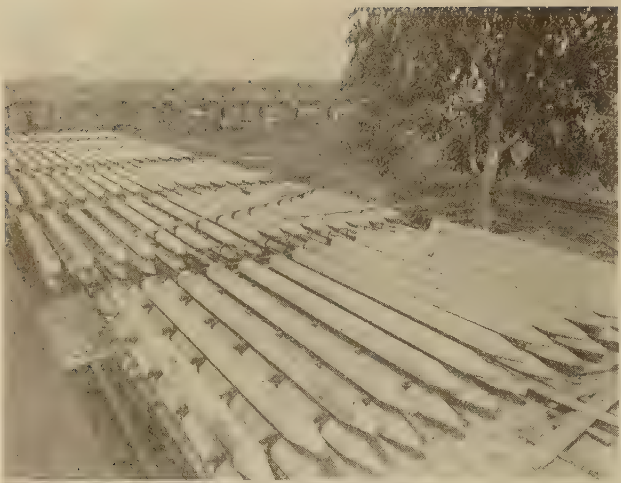
There is perhaps no other precast unit in which greater care is necessary in manufacture than in a concrete pile. It is not only subject to handling and shipping stresses, but must also resist the impact of the driving hammer as well. However, when reasonable care has been taken and a uniformly high strength concrete secured, the question of handling and shipping precast concrete piles is not a very difficult one.

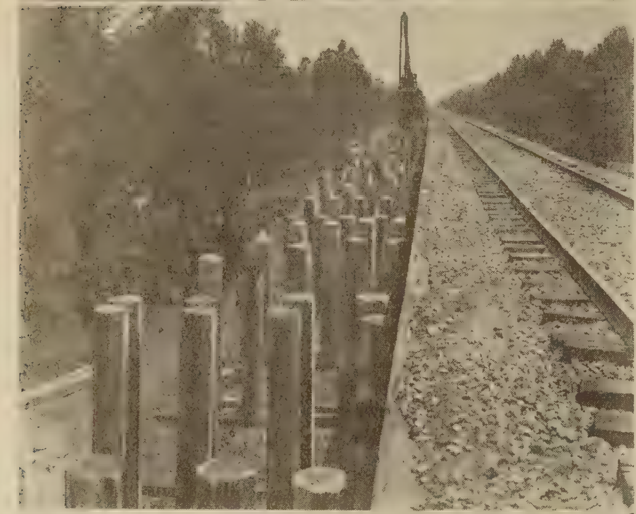
Many methods of manufacture have been tried. One of the first was the so-called Chenoweth process, in which a thin layer of concrete was spread on a wide strip of wire mesh. The mass was then rolled into a pile by a special machine, making the cross section resemble a jelly roll cake.

This process did not prove entirely successful and today most precast piles are cast in octagonal molds resting on their side and having one face open for filling with concrete. The face opposite the open one is usually a wooden pallet to which metal forms of the remaining sides are attached. Welded steel rings form the hooping and the longitudinals are steel rods running continuously from tip to butt except for the addition of shorter bars in the center section in the case of longer piles.

To secure the necessary high quality of concrete in precast piles, proper spading, uniform mix, good aggregates, clean steel, control of mixing, the water, and proper hydration must be insured. For this reason, tight forms, batch mixing, and batch conveying of the concrete to the forms are necessary. By nesting the piles one on top of another—in other words using one pile as a foundation for the bottom of the nest—it is possible to more easily hydrate the piles properly and space is saved.

Tests are now being conducted on a type of pile that is manufactured in quite a different manner from that just described. The successful manufacture of concrete poles in longer lengths during recent years by the centrifugal process has made it seem feasible to use the same process for manufacturing piles. The fact that such piles are hollow possesses the added advantage that where jetting must be resorted to, the hollow center forms a jet pipe so that only a connection at the top is necessary. It also gives a better distribution of the concrete, increasing its resisting moment per pound of dead weight over the solid cast pile. Piles of this description have been driven recently both by the jetting process and with a steam hammer, and the experiments have been so successful that there seems no doubt that this form of construction will take its place among the recognized foundation standards.





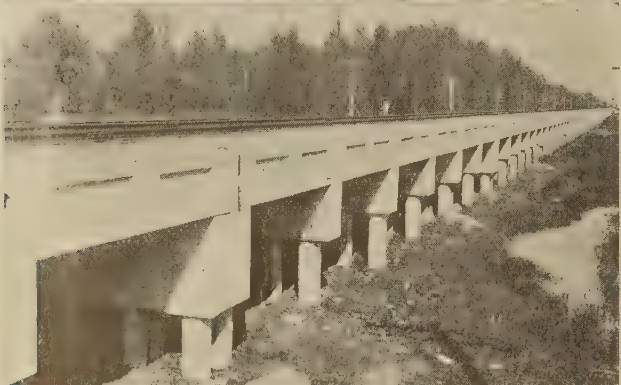


Fig. 1—Precast Concrete Piles in Storage Yard

Fig. 2—Driving Concrete Piles

Fig. 3—Completed Railroad Trestle Supported on Concrete Piles

Driving

There are two principal methods in use for driving concrete piles. The first consists of jetting the piles in place, sometimes giving them a final setting with a hammer. This method is particularly useful in the case of sandy soils where hammer driving is very difficult, and where at the same time considerable penetration must be secured. Frequently it is found that on account of scour or possible future dredging it is necessary to carry the foundations to a deeper point than is absolutely required by the bearing power of the piles. The water jet in this case is usually the most economical method of driving.

In recent work, a pressure of 150 lbs. per sq. in. applied through a 2-in. tube pointed at the end to 1 in. has proved to be a satisfactory arrangement for the solid cast piles. The same water pressure can be used in connection with the centrifugally-made piles, whose point, of course, forms a jet of its own.

The second method of driving is with a hammer, either a drop or a steam hammer. More elaborate arrangements are necessary when the pile is to be driven with a hammer, and to illustrate these arrangements, we will discuss the details of driving a typical railroad pile trestle.

In the first place, it may be stated that in general the drop hammer has a much greater shattering effect in proportion to its driving effect than the steam hammer. For this reason a steam hammer is usually recommended. Its weight should not exceed 5,600 lbs. and it should be provided with a standard hood and follower. Laminated wood blocks or special driving head with cushion of sand, rope or other material should be placed between the driving block and the head of the pile.

Since concrete piles are not as easily cut off if too long and span lengths not as easily changed in concrete trestles as in wood, the driving of concrete piles to the exact position specified in the plans is an exacting problem. On sloping banks and at other points if necessary, a hole 3 to 5 ft. deep should be dug with a post hole digger at the location of each pile to aid in holding it in the proper position. On more level ground, a "checker-board" may be used. This consists of a frame of 8-in. x 16-in. stringers with spaces through which the piles can be driven. This frame is held securely in position on the ground by struts from the adjoining bents.

All concrete piles should be driven as nearly as possible in a plumb position. Before driving is started the pile should be carefully plumbed and the driver leads held in the proper position by guys. The top of the pile may also be strutted to hold it in position. If the pile gets out of line in driving, the ground may be dug away from one side to as great a depth as practicable and the pile pulled or jacked into place. It is sometimes found desirable to station one man on the center line of the bent being driven and another on a line parallel with the center line of track and opposite the pile being driven, so that by proper signals the foreman can be warned of any tendency of the pile to go out of line. Some engineers require that if, in spite of all these precautions, a pile goes out of plumb more than 3 in. at the cap, it shall be pulled and redriven. (It should be noted that this is not necessary in foundation work.)

The driving of concrete piles should be light until the pile has obtained somewhat hard bearing, after which the intensity of the driving may be increased. If care is taken to keep both the pile and the leads plumb, the tendency to shatter will be greatly decreased. Every effort should be made to drive the piles to the cutoff shown in the plans. Satisfactory bearing is indicated by 100 blows for the last foot of penetration. If plan cutoff is reached before this bearing is secured the pile may be allowed to stand for a day before driving is resumed.

Where it is not possible to drive piles to plan cutoff, it is necessary to remove the portion of the pile above that point. Where not more than 3 ft. of the pile remains above cutoff, this portion may be removed without cutting the reinforcement. Where more than this amount remains, the concrete should be removed to the cutoff line, and the reinforcement cut off about 2 ft. above that point. This reinforcement should then be separated and bent down to a horizontal position.

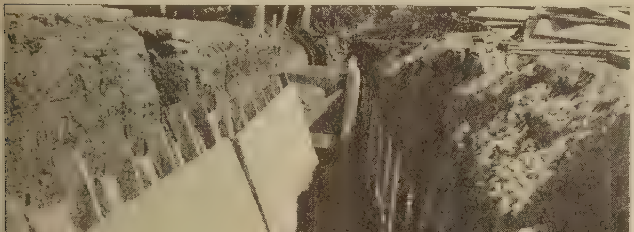
Colorado Springs Sewer Follows New Principle

Rectangular Storm Sewer, Curb and Gutter Cast Integrally

Early in 1921 the city of Colorado Springs undertook an extensive improvement campaign consisting of about 250,000 sq. yds. of paving and many miles of storm sewers. Because of the extensive nature of the job, work was carried over into 1922 and considerable storm sewer construction was done last year.

The construction of the storm sewer on West Colorado avenue involved special difficulties because of the presence of gas, water and sanitary sewer mains at the ordinary depths. These occupied the ground from 3 ft. below the surface to a point 7 ft. deep and a sewer placed below the 7-ft. depth would have been very expensive to build and some difficulty would have been experienced in excavating around the numerous service pipes.

The city engineering department, under the direction of Frank Ray, city engineer, worked out a design for a rectangular monolithic reinforced concrete sewer which solved the problem. The sewer is built partially under the curb and gutter, the curb and gutter being placed monolithic with the sewer, and the gutter flag forming the top slab of the sewer. On the smaller sizes, of course, the 30-in. gutter flag practically spans the entire sewer structure, while on the larger sizes the gutter is continued monolithic with the top slab of the sewer. Where the sewer crossed the streets intersecting Colorado avenue, the shape of the top slab was made to conform to the crown of the street. There is a total of 5200 lin. ft. of the sewer with curb and gutter, about 3700 lin. ft. of sewer without curb and gutter, and 100 lin. ft. of open concrete box.



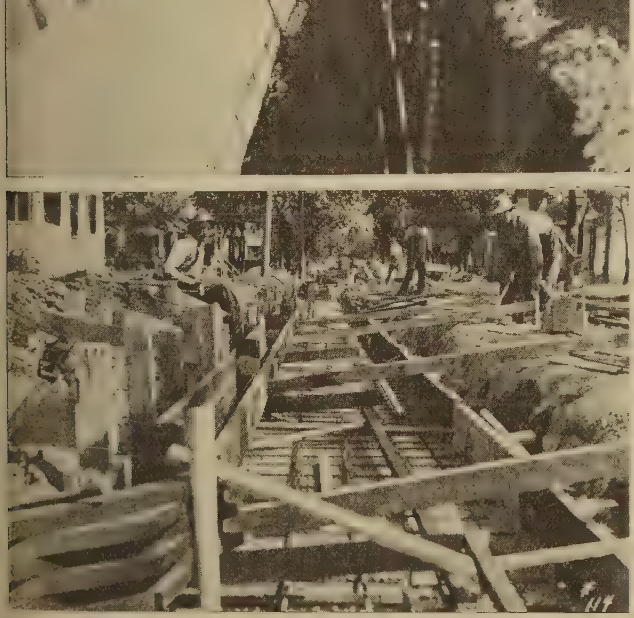
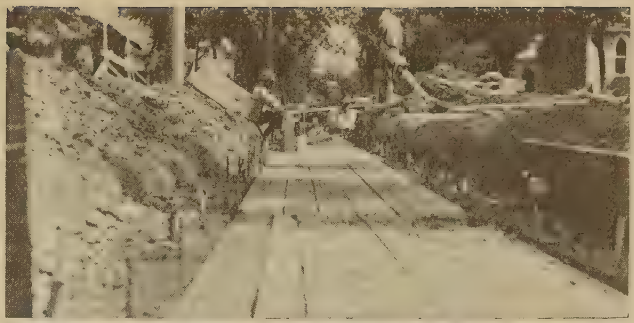
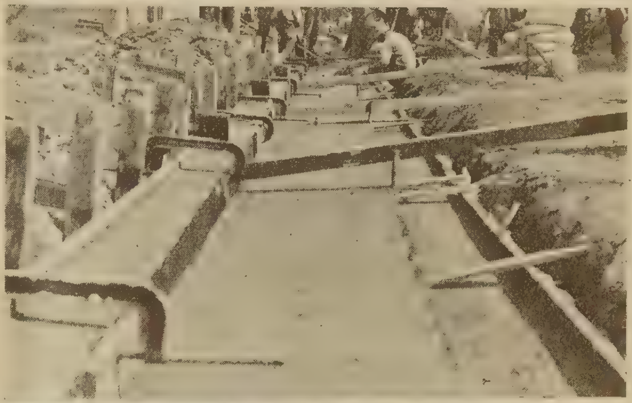


Fig. 1—Setting Side Forms for Combined Curb, Gutter and Sewer at Colorado Springs.

Fig. 2—Forms and Reinforcing in Place for Curb, Gutter and Slab Forming Top of Sewer





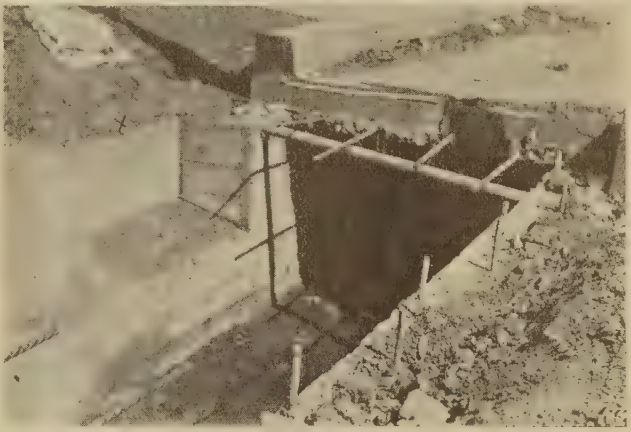


Fig. 3—Forms in Place for the Sewer Roof

Fig. 4—Finishing Curb, Gutter and Top Slab of Sewer

Fig. 5—View of the Completed Sewer at Colorado and 23rd Avenues, Colorado Springs, Showing Method of Construction at Catch Basin Openings

The sizes of the sewer range from 2 ft. x 1 ft. to 6 ft. x 3 ft. The drainage area is 400 acres, part of which consists of low but steep hills containing considerable rock. The run-off from this part of the drainage area is large and rapid and contains considerable solid material in suspension particularly after a heavy rain.

One of the marked advantages of this style of construction is the elimination of manholes and catch basins as ordinarily known. Inlets for the water consisted of depressing the gutter slab and providing an opening between the curb and gutter so the water could flow directly into the sewer. Manholes were provided along the length of the sewer but consisted only of setting a manhole ring and cover to grade in the top slab of the sewer through which direct access to the sewer is obtained. Completed top slabs were covered with moist earth to insure proper curing.

A comparison of the prices of this sewer with pipe prices, both complete in place, may be of interest. In January 1922, the city of Ft. Collins, Colorado, received bids on concrete pipe, clay pipe and segmental block for a large storm sewer. Sixteen bids were received and the prices shown in the table below are those of the successful bidder, who installed concrete pipe. No sizes above 48-in. were included, hence comparison of the first two items is not possible.

Area (sq. ft.) Rectangular Sewer	Diam. in Inches of Equivalent Circle	Diam. in Inches of Pipe at Ft. Collins	Ft. Collins Prices	Colo. Sprgs. Prices
16.5	55½	..	....	$7.60
15.0	52½	..	....	7.55
12.0	47	48	$8.32	6.65
9.0	40½	42	6.65	5.45
7.5	37½	36	5.05	5.35
4.5	28½	30	4.13	4.60
4.0	27	27	3.82	4.05
3.0	23	24	2.53	3.80
2.5	21½	21	2.30	3.70
2.0	19	18	1.76	3.50

The Colorado Springs prices shown are those without the curb and gutter. The average increase in price per lin. ft. of sewer to add the curb and gutter on the Colorado Springs job was $0.61. This represents the curb chiefly. On the other hand, where catch basins and manholes are usually quoted from $60 to $80, the low bids at Colorado Springs on manholes and inlets were $18 and $17 respectively, representing a substantial saving on a large job. Another saving occurs in the fact that the top slab also serves as the base of the pavement and on the larger sizes was an item of considerable importance.

Bids for the work were received on April 25, 1922 and contract awarded to J. R. Donaghy of Colorado Springs. Work was started about May 15 and completed about October 15. Approximately one block of floor was laid at one time after which the side walls and top slab were placed. The photos illustrate the methods of constructing the various parts of the sewer. C. C. Eastham, assistant city engineer, was in charge of construction.

Cost and Results of Road Maintenance in Wisconsin

The five-year costs and results of patrol maintenance of state roads by county work with state supervision in Wisconsin is shown in the accompanying table from a paper by J. T. Donaghy, maintenance engineer, Wisconsin Highway Commission, presented at the recent convention of the American Road Builders Association.

The table shows the actual miles maintained by patrol methods each year, the number of patrol sections, the salary paid patrolmen, the patrol maintenance cost of each type per mile, and the amount expended per mile out of maintenance funds for "betterments." "Betterments" consist of widening the road and providing drainage with heavy blade grader work, light resurfacing, new culverts, and the cost of marking and signing the system:

	Year	1918	1919	1920	1921	*1922
	Actual Miles Maintained..	4,998.9	4,998.9	7,234.0	7,260.4	7,458.59
	No. Patrol Sections.....	561	561	791	911	940
	Monthly Salary Team Patrol.	$130.00	$145.00	$165.00	$155.00	$150.00
	Monthly Salary Motor Patrol	$ 90.00	$110.00	$125.00	$115.00	$100.00
Patrol Maintenance Cost Per Mile	Earth	$135.21	$154.01	$187.24	$196.21	$186.40
	Gravel....	$120.80	$133.63	$184.68	$193.85	$183.25
	Stone and Gravel Surface Treated.	$574.21	$626.33	$706.11	$682.23	$671.84
	†Concrete.	$162.21	$210.42	$220.18	$322.21	$311.85
	Cost Patrol Maintenance.	$573,042.16	$767,302.12	$1,220,535.00	$1,326,927.24	$1,355,900.00
	Cost of Betterments .	$396,449.65	$488,529.68	$756,474.38	$1,028,976.04	$952,850.00
	Cost of Marking and Signing..	$7,888.22	$17,776.16	$28,820.61	$20,462.14	$41,250.00
	Total Expenditures........	$977,430.93	$1,273,607.86	$2,005,829.89	$2,381,413.85	$2,350,000.00

The above total expenditures average $278.00 per mile per year.

*Final costs will vary somewhat from figures shown, as the season is not complete at this date (Dec. 15, 1922).

†Annual costs include all shoulder maintenance, which runs high on all surfacings less than 18 feet.

During the first month of patrol maintenance in 1918, the actual driving conditions in Wisconsin were improved far beyond the expectations of the most optimistic friends of patrol maintenance. Again, when the entire system was adequately marked during the week of June 22, 1918, making it possible for the dumbest person from out of the state to travel the length of Wisconsin without asking directions, the public expressed its approval of the system in no uncertain terms.

Several county boards met in June, 1918, and provided for patrol maintenance on important secondary roads. The growth of this sentiment is shown by the following table showing the miles of county trunk highways taken over for maintenance each year by the several county boards, number of patrolmen employed, salary, cost of marking and signing, and total expenditures:

Year.........	1918	1919	1920	1921	1922
Miles Maintained..	2,021	5,590	7,743	8,980	9,885
Number of Patrolmen...	232	705	970	1,123	1,236
Average Monthly Salary of Patrolmen...	$125.00	$140.00	$160.00	$150.00	$145.00
Cost of Maintenance.	$475,000.00	$1,226,267.00	$1,435,527.00	$1,867,615.00	$2,279,804.00
Cost of Marking and Signing..	....	$3,600.00	$9,300.00	$8,100.00	$11,000.00
Total Expenditures........	$475,000.00	$1,229,867.00	$1,444,827.00	$1,875,715.00	$2,290,804.00

The above total expenditures average $214.00 per mile per year.

To quote from Mr. Donaghy's paper:

In April, 1917, a law was enacted creating a State Trunk Highway System to be selected by the Highway Commission and a special committee of five legislators appointed by the Governor. The law provided that on May 1, 1918, the counties must take over the maintenance of the system selected.

For convenience in handling road matters, the Commission has established nine divisions, containing approximately eight counties each. A resident engineer, called Division Engineer, is in charge of each division, having the necessary assistants to plan and supervise properly the work in each division. An assistant, known as Division Maintenance Engineer, has charge of all maintenance, marking and signing. The latter visits each patrolman at least twice a month, reporting each visit by card to the main office. In 1922, 10,940 visits were reported, giving us accurate information at all times as to the exact condition of each section.

Each county is governed by a county board, consisting of a representative from each township and village and also one from each ward of every city. The county board elects a committee of three to represent it in all matters connected with road work, and also elects a county highway commissioner who has direct charge of all road construction and maintenance work done by the county. Each county highway commissioner has an assistant known as Patrol Maintenance Superintendent who is in charge of maintenance. He visits each patrolman at least twice each week, insuring very close supervision.

The county road committee really acts as a board of directors and as a buffer between the county highway commissioner and the county board on the one hand and the State Highway Department and the county board on the other.

Prior to the selection of the system authorized by the legislature, our division engineers made a condition survey of all competing roads showing the actual conditions existing on every mile. After the selection of the system another survey was made, at which time the distance was measured accurately and stakes set each mile locating future mile posts. The information on each mile shows by tenths of a mile the soil, drainage, type of surface and condition. This information was very helpful later on in planning the patrol system in each county.

The law under which we operate did not provide especially for a system of patrol maintenance. It did, however, provide that "each county must adequately maintain the portion of the system lying within the county, according to the specifications, directions and to the satisfaction of the Highway Commission."

The Commission determined, however, that a thorough patrol system must be installed at the very beginning which would cover every mile on the system, whether previously improved or not. The portion of the system lying in each county was divided into patrol sections by the county committee, acting jointly with the county highway commissioner and our division engineer. The patrolman for each section was selected in the same manner. The county committee advertises in the local press that on a certain day those seeking the jobs of patrolmen for the coming season must report at the county court house. The applicants "if new" are interviewed by the county committee and our division engineer and the most promising candidates are given the positions. Applicants having served as patrolmen one or more seasons are given preference over new men and they usually receive more salary.

Each patrolman enters into a written contract with the county and gives a bond in the amount of $500 for the faithful performance of the work and proper care of the tools and machinery intrusted to him. The contract is also subject to the approval of our division engineer.

"On team patrol sections" the patrolman must furnish a team and wagon satisfactory to the county, the county furnishing a light blade grader, road planer, plow, slip scraper and miscellaneous small tools. On "motor truck or tractor patrol sections" the county furnishes all the equipment.

The salaries paid on team patrol sections range from $140 to $165 per month for the 1922 season; those on motor truck and tractor patrols average about $110 per month. The season extends from about April 1 to December 1, and from December 1 to April 1 the patrolman agrees to work when requested at a fixed price per hour.

The "team patrol sections" average about six and two-thirds miles each, and as a rule are confined to earth road sections and those gravel sections that carry light traffic. We have few tractor patrol sections. They average about twelve miles in length and are generally confined to earth roads but are sometimes preferable on heavy traffic gravel roads where heavy maintenance equipment is necessary. Motor truck patrol sections average about eighteen miles, and are economical only on heavy traffic roads where heavy maintenance equipment is necessary and where new material must be hauled regularly, on surface-treated stone or gravel, and for work on concrete surfacings. We find that on earth or gravel sections where traffic does not exceed an average of 200 vehicles per day the "team patrol" is cheaper and more satisfactory than any other.

The tables bear out our original ideas and prove to us, at least, that the plan of operating through the counties has resulted in local demands for more roads to be maintained each year by patrol methods and consequently a much greater mileage of patrolled roads. In addition to the 7,500-mile State Trunk System, we now have a 9,880-mile County Trunk System, making a total of 17,380 miles of well maintained roads. This gives more than 80% of our population direct service, and brings patrolled roads within two miles of the remaining 20%.

RESULTS OBTAINED

After five years of patrol maintenance we find that the following conditions prevail:

(1) Every town, city or village in the state is on a well maintained and marked highway.

(2) Traffic is distributed over a large mileage, reducing congestion on many highways.

(3) The average speed of traffic has been increased at least ten miles per hour, resulting in time-saving beyond computation.

(4) Night driving is safe and practical and our traffic census shows a marked increase each year in night traffic. Prior to five years ago, no sane person would think of driving from Milwaukee to our northern lake district during the night (300 miles), while now the practice is becoming very common and popular.

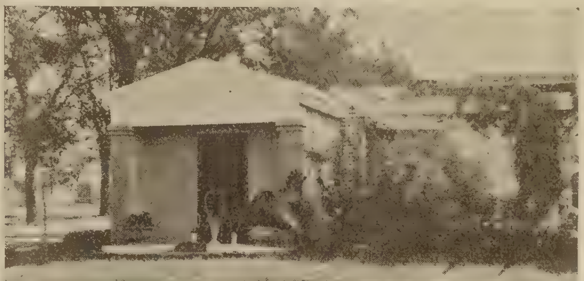
(5) Prosperity immediately becomes noticeable. The farmers along such routes soon vie with each other in promoting neatness in their road fences, farm buildings and entrances. Farm names appear over the gateway and the mail boxes are given a fresh coat of paint. Letterheads even show the location of the farm by Trunk Highway route and mile number. Products of the farm are sold direct to the city dweller at a price satisfactory to both. In the villages and cities along the routes new Inns or Tea Rooms, rest rooms and garages spring up to serve traffic.

(6) Last, but not least, is the tourist, and our definition of a "tourist" is any person using our highways for pleasure, whether a resident of Wisconsin or not. They tell us that we have the best maintained and marked highway system in the world.

We are satisfied that during the five years of patrol maintenance, 1918-1922, the tourists have left not less than $300,000,000 in Wisconsin. Figuring a net profit of but 20%, which is very conservative, the profits from this source would be $60,000,000, or about seven times the total expended for patrol maintenance and marking and signing the State Trunk System since April 1, 1918.

Kesterson Mausoleum

The picture (Fig. 1) shows the Kesterson Mausoleum, Superior, Nebr. It is built largely of concrete, and has some unusual features. Bird life has been called upon to relieve the solitary stillness. The mausoleum contains four crypts, one for each member of the family. The main exterior is coated with portland cement stucco of a rather coarse texture. Precast concrete stonework of excellent quality surmounts the square columns in front. The roof is a reinforced concrete slab cast in place. An arbor extends from the south of the building, covered with vines and surrounded by plants and shrubs. Bird houses of quaint design have been placed among the vines, while in a secluded place behind the shrubs there is a small fountain kept running at all times during the hot summer months to provide drinking water and a bath for the birds.



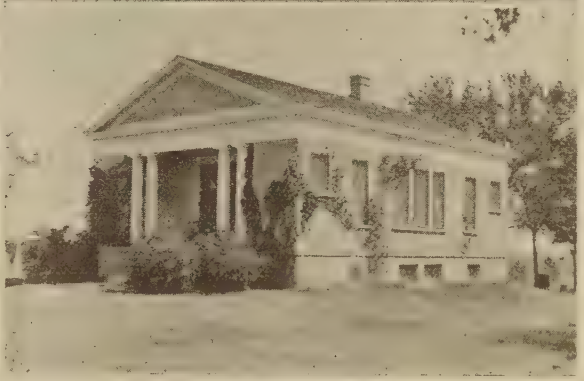


Fig. 1—Mausoleum with Unusual Features

Fig. 2—Stucco Chapel

Another interesting structure in the same cemetery is a small stucco chapel, (Fig. 2). A basement extends under the entire building, its walls of concrete blocks carried up to the level of the water table. The entire exterior is coated with white portland cement stucco, the beauty of which is further enhanced by shrubs and vines. The Superior Cemetery Association has adopted a policy of encouraging the use of concrete because of the permanency of this material.

Coal Pockets of Concrete Staves

The new coal pocket installation of the Tanner-Rome Coal Co., Chicago, of concrete stave construction, is of more than usual interest. The construction season of 1922 may be credited with 200 or more new concrete stave pockets as well as numerous construction and sales ideas of future value to the industry. The Tanner-Rome pockets, embodying many of these ideas, are undoubtedly among the best of their type.

The Playford Manufacturing Co., Logansport, Ind., erected the pockets, using heavy duty staves (12 in. wide, 2¼ in. thick and 30 in. long) of the Ribstone (ribbed) variety with an overall thickness of 4½ in. through the ribs. These staves are reinforced with ¼-in. round rods embedded in the vertical ribs. (Ordinary strength silo staves of the same design are considerably lighter, having a slab thickness of only 1⅞ in. and usually containing no reinforcing.)

Three tanks 20 ft. in diameter and 42 ft. 6 in. high provide storage capacity for slightly over 1,000 tons of bituminous coal. Each tank required a total of 1,053 staves.

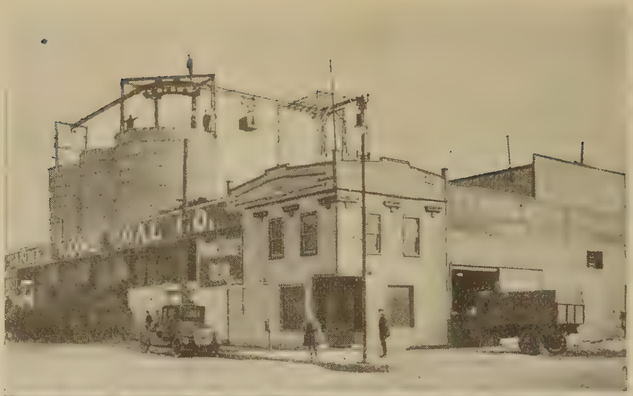
Footings for the tanks were carried 3 ft. below grade and are 2 ft. wide at the base, tapering to 1 ft. wide at grade. The concrete stave walls are reinforced with ¾-in. round steel rods having rolled threads to $\frac{13}{16}$-in. These rods, which are exposed, are spaced 15 in. on center up to the last 10 ft., above which they are spaced at 30 in. There are no partitions in any of the tanks. The floors, surface of which is 10 ft. above grade, are heavily reinforced and 12 in. thick. The floors are not attached to the walls but rest on pedestals. Each tank has two openings 36 in. square into which the gates and chutes are fitted. Heavy steel chutes were installed with interchangeable screens for removing the dust or smaller sizes from the coal without the labor of an extra screening operation. Owing to the type of conveying equipment selected, it was decided not to place permanent roofs on the tanks.

Bucket type conveyor was installed by the Universal Conveyor Co., South Bend, Ind. This equipment probably has an average capacity for handling 4 to 5 carloads of coal daily. If operated continuously the conveyor will unload a 50-ton car, placing the coal in the tank nearest to the unloading hopper, in 2 hours. The average operation is nearly 25 tons per hour. The bucket holds 1 ton of bituminous or 1¼ tons of anthracite coal. A 10 H. P. motor drives the hoist, although the builders believe a 7½ H. P. motor to be ample. At Chicago rates, the cost of power averages about one-half cent per ton or slightly over.

Where the railroad siding is approximately at grade, it is necessary to construct a track hopper with pit below the track level, into which the bucket travels for its load. In the case of the Tanner-Rome installation, it was not necessary, fortunately, to provide a pit, since the siding comes in on a trestle about 14 ft. above ground level. The track hopper was placed immediately under the trestle and the bucket merely descends to the ground level for its load.

Each gate has a capacity for loading a ton a minute into the wagons or trucks, or if desired in sacks, the wagons or trucks can be loaded at the rate of 1 ton in five minutes. Recently a ten-ton truck was loaded from one of these tanks in five minutes. This represented an actual saving of time of over an hour, compared with common hand-loading methods.

It is quite interesting to note that practically all grades of coal commonly known in the Chicago market have been successfully handled through these pockets in the winter months just passed.



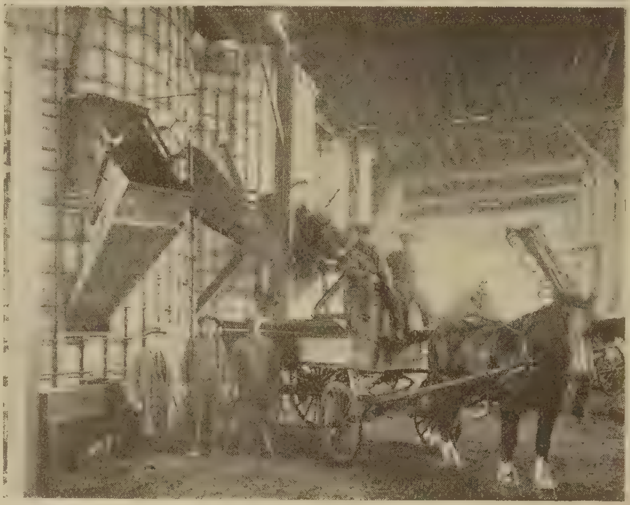


Fig. 1—General View of Concrete Stave Coal Pocket Installation of the Tanner-Rome Coal Co., Chicago, from Street

Fig. 2—Concrete Stave Coal Pockets, Showing Chutes

Traveling Scholarship Competition

Alfred C. Bossom, architect, New York city, who studied in England and later in America, is offering silver and gold medals and a traveling studentship to English architectural students. All large architectural schools in Great Britain are invited to compete for the prizes. Each year The Royal Institute of British Architects will arrange some definite practical problem built around the designing of a commercial structure such as an office building, hotel, apartment house, warehouse; the student will submit not only the design but also the most accurate approximate statement possible of costs and a financial statement as to the probable revenue, upkeep, costs, depreciation, and so on. The Judges will be a group of men consisting of a prominent architect, a prominent builder and a prominent business man. Silver medals go to the best design in each school, and these winners compete for the gold medal and six months' study in America. The returning student makes a report on commercial architecture. This scholarship plan is being enthusiastically backed by The Royal Institute of British Architects and by English business men, who see in it a stimulating influence bound to somewhat relieve the serious building slump and labor unemployment.

Improvements in Concrete Practice

Application to Actual Construction Work of Scientific Principles of Making Concrete

A Review By G. E. Warren
Assistant General Manager, Portland Cement Association

In the last ten years rapid strides have been made in the study of concrete. Many laboratories have investigated various phases of concrete work and have definitely determined factors governing its strength and durability under usual conditions. In fact, investigations have progressed so far that concrete mixes can be designed to attain any desired compressive strength up to 4,000 pounds per sq. in. at 28 days. Several of the more important of these investigations have been made by the Structural Materials Research Laboratory, Lewis Institute, Chicago.

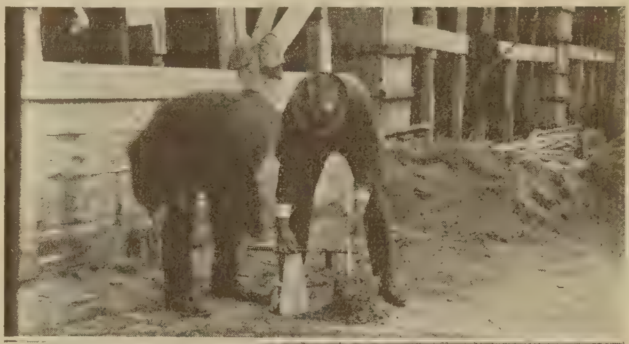
As a result of the wide publicity given the results of these laboratory studies, there has been a slow but steady improvement in general concrete practice. Some so-called "practical" men deride laboratory results and refuse to apply them, possibly through fear of admitting their own ignorance. Others, however, realizing the wonderful possibilities of improved quality and greater usefulness offered by the application of scientific principles to practical work, have blazed a path that other up-to-date concrete men will soon follow. In general, the results have been excellent; in some cases the strength obtained has been way beyond the maximum that was considered possible a decade ago.

Thinking that information on "the other fellow's" efforts to improve his concrete practice would be of interest to readers of Concrete, the following summary of the work and results of several organizations has been prepared. Part of the data is from the 1923 report of the Masonry Committee of the American Railway Engineering Association.

Consistency

The wide publicity given the injurious effect of excess mixing water in recent years has led to a reduction in the quantity of mixing water in most concrete work. The slump test for measuring and controlling consistency is being used more and more. It is a simple test that can readily be made by any competent inspector or foreman. A metal form, shaped like a frustrum of a cone, four inches in diameter at the top, eight inches at the bottom, and twelve inches high, is filled with the concrete to be tested. The metal form is then lifted off and the settlement or "slump" of the concrete noted. Obviously, the smaller the slump the less the quantity of mixing water and the stiffer the consistency. The specifications of fifteen state highway departments now require the slump test and limit the slump to a small amount (usually two inches or less).

In constructing a large reinforced concrete apartment hotel in Chicago last fall, the architects and contractors cooperated to limit the quantity of mixing water. Slump tests were made frequently, the maximum slump permitted being seven inches. In reinforced concrete buildings a consistency as stiff as this is more difficult to use than in most concrete work, but is easily possible if a little care is taken.



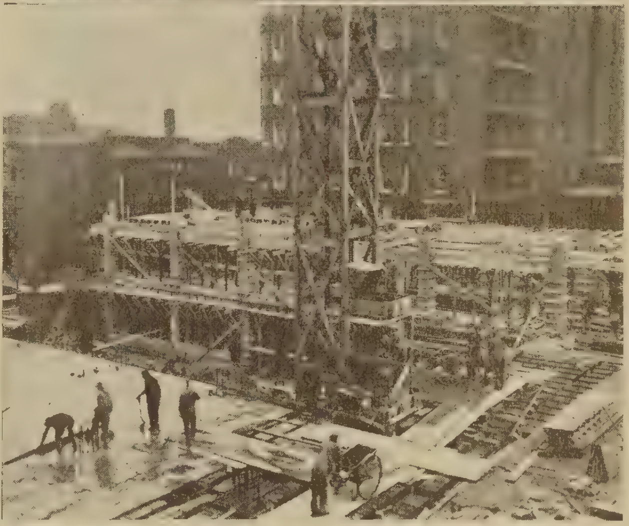


Fig. 1—Making Slump Tests on Chicago Apartment Hotel Construction

Fig. 2—Apartment Hotel Under Construction

Colorimetric Test

The colorimetric test for organic impurities in sand is being made even more widely than the slump test. It is now required by many highway, building and other concrete specifications.

The presence of decaying vegetable matter, manure and similar organic impurities in aggregates in amounts too small to be visible may prevent concrete from attaining its full strength, or may even keep it from hardening at all. Such impurities are readily detected by the colorimetric test. A small sample of the sand (an 8-ounce bottle half full) is shaken vigorously in a dilute (3%) solution of sodium hydroxide (enough of the solution to fill the bottle over the sand to the 7-ounce mark); after the sand has settled to the bottom the color of the liquid on top indicates the absence or presence of organic impurities. This test is so cheap and easy that there is no excuse for defects in concrete due to such impurities.

PROTECTION DURING EARLY HARDENING

Keeping concrete damp during the first ten days adds over 65 per cent to its compressive strength. Continuing this protection for three weeks more than doubles the strength. Realizing this greatly increased value, obtained at practically no cost, most highway engineers now insist that concrete pavements be cured either by covering them with damp sand or earth, or by flooding them with water. Similar methods are used for concrete platforms and concrete floors. An example of the latter was the flooding of a concrete floor in a large one-story industrial building in Milwaukee. This one improvement in concrete practice means a great increase in the strength and durability of concrete.

SIEVE ANALYSES

Tests of the grading of aggregates and determination of proportions that will give the best results are also coming into use and their value is gradually being realized. Among other organizations which have used these principles successfully are the following: New York Central Lines West; Utah Highway Commission; Iowa Highway Commission; Nevada Highway Department; Maine Bridge Department; Hydro-Electric Power Commission of Ontario; Canada Cement Co. Office Building, Montreal.

The New York Central Lines West has established a concrete testing laboratory at Cleveland, Ohio. It is fully equipped for making sieve analyses to determine the grading of aggregates, colorimetric tests, and slump tests as well as for testing cement. Slump tests are made regularly on the work and every effort is put forth to limit the slump to not more than 7 inches. The results have been very satisfactory.

In building concrete roads, the Utah Highway Commission is applying the principles of construction developed by laboratory investigation. The quantity of water is strictly limited, consistency being regulated by the slump test. All sand is subjected to the colorimetric test before use. Screen analyses are frequently made of all aggregates and the proportions are changed accordingly. Instead of varying the proportions so as to obtain a given strength in the concrete, however, the Utah Highway Commission varies them so as to get the greatest strength from a given cement content (1.7 bbl.) per cubic yard of concrete. The results have been excellent, the strength of the concrete averaging between 4,000 and 6,000 pounds per square inch at 28 days.

The Iowa Highway Commission limits the quantity of mixing water used in concrete road construction and varies the proportions in accordance with the grading of the aggregates used. Slump tests and sieve analyses of aggregates are made frequently on each job. Concrete having a strength of 3500 pounds per square inch at 6 months is desired. The results for the entire year 1921 were as follows:

1. Average strength of all concrete placed was 5200 pounds at 6 months.
2. The lowest strength result was 2950 pounds.
3. The maximum strength result was 7100 pounds.
4. The lowest average strength obtained on any one job was 4400 pounds.
5. The highest average strength obtained on any one job was 6200 pounds.

The mixes used varied from 1:2.30:1.54 to 1:2.0:3.5. In some cases the sieve analyses showed that nearby deposits of bank run gravel could be used, thus decreasing costs. In those cases the proportions varied from 1:3.25 to 1:4.84. The above strength results show the excellent quality of concrete that can be obtained through application of the principles developed by laboratory investigations in recent years.

The State Highway Department of Nevada has been able to solve many problems through the application of these principles. One instance is cited in the following paragraphs from a letter written on July 21, 1922 by George W. Borden, State Highway Engineer:

> It is very satisfactory to me that you use this office as a reference regarding the results we got by the practical use of Professor Abram's theories regarding concrete mixes. I can affirm your statement that the new proportion of material from Lahontan Plant enabled us to use our entire output, thus saving approximately 1/6 of the material which we had to dispose of in some other manner, and also the new mix with the reduced water content increased our unit strength from 2,000 pounds to 3,000 pounds at once.

Thus the application of correct principles increased the strength of concrete 50% and caused a saving of 15% in materials.

The University of Texas tested a section of concrete cut from a pavement built at Wichita Falls, Texas, in strict accordance with laboratory principles of making good concrete. The following paragraph is quoted from a letter written by the testing engineer to the City engineer of Wichita Falls:

> We want to congratulate you on the unusual strength you have obtained in this concrete pavement. The strength obtained, 6,310 pounds per square inch, is the highest that we have seen for concrete any where near this mix, except a few rodded concretes which we have made in this laboratory, and your pavement will, no doubt, be good for a great many years to come.

The bridge department of the Maine Highway Commission is contracting for concrete on a strength basis contracts being made on a unit price and not a lump sum basis.

Specifications dated May 1921 specify four classes of concrete for culverts and bridges, viz:

Grade	28 day Compressive Strength lbs. per sq. in.
A	3,000
B	2,300
C	1,700
D	1,200

Compressive strength is determined from an average of five tests, made from concrete cylinders molded from concrete taken from the middle of batches, and at such intervals as directed by the engineer. Concrete of each grade must have a strength not less than the strength specified above. A letter from Capt. L. N. Edwards, bridge engineer, indicates that he is pleased with the results obtained under these specifications. He states in part as follows:

> I have not known of a single criticism from contractors of the "concrete strength requirement." I consider this rather remarkable inasmuch as it has taken every contractor bidding upon our work into a new field with which they were totally unfamiliar.

In view of the criticisms made by some contractors of the "concrete strength requirements" proposed in the Progress Report of the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete, Captain Edwards' experience is of particular interest.

HYDRO-ELECTRIC DEVELOPMENTS

In placing 410,000 cu. yds. of concrete on the Queenston-Chippewa project, in a period of 13 months, the Hydro-Electric Power Commission of Ontario limited the qnantity of mixing water, used the slump test, maintained given water-cement ratios, studied the grading of the aggregate, and varied the proportions from time to time to fit conditions. This work is described in two articles by A. C. D. Blanchard and R. B. Young in the *Engineering News Record* of April 6 and April 13, 1922, and also in the July, 1922, issue of CONCRETE.

Sand from several different sources was used. The pit sand was found to have an average fineness modulus of 2.7 and the lake sand 3.2. Mainly because of this difference in grading, the pit sand required about one-half bag of cement more per cu. yd. of concrete than the lake sand to attain the same results under identical conditions. Crushed rock from the canal excavation was used as coarse aggregate. Its grading was practically uniform.

Four classes of concrete were used. Class A was of such quality as to have a strength of 2,500 pounds per square inch at 28 days when tested according to methods essentially the same as those of the A. S. T. M. Classes B, C and D concrete were required to have strengths of 2,000, 1,500 and 1,000 pounds per square inch respectively under the same conditions. This requirement made it necessary for field forces to regulate materials, proportions, and construction methods so as to obtain concrete of the desired quality.

The grading of sand was inspected at the source of supply, inspectors being provided with sieves, and sand not meeting specifications was not loaded. Other inspectors at each concrete plant made further tests and had power to change the proportions as required by the grading of the aggregate, within general limits which were set by the chief inspector.

The consistency used was such that the concrete flowed readily, but without segregation, down chutes having a slope of 2½ to 1. *Where a wetter consistency was required, enough cement was added to maintain the same water-cement ratio.* Vice versa, when a drier mix could be used, the quantity of cement was reduced proportionally.

As a result of this care, the concrete was of uniform quality, fully meeting the specifications. In the year ending November 1, 1921, 74% of the test cylinders either met or exceeded the strength requirements, while 87% either met the requirements or did not fall below them more than 200 pounds per square inch. Results of tests of concrete placed during May, June and July, 1921, on the power house, when work was being rushed, are given in Table I.

Comparing the amount of cement actually used with the Commission's original estimate, the saving was 35,490 barrels; comparing it with estimates given in Taylor and Thompson's *Concrete—Plain and Reinforced*, the lowest of the authorities consulted, the saving was 56,650 barrels.

The additional cost of these methods was less than 0.1% of the cost of the concrete. The field laboratory equipment cost less than $1,000, and only one extra man was employed. The total cost of these methods, including preliminary investigations of a general nature that should be pro-rated over all of the Commission's concrete work, was less than the saving in cement alone. Thus these methods actually reduced the cost of the concrete. In the words of Mr. Young, "It was found possible to control the strength and quality of the concrete and at the same time reduce the quantity of the cement below that normally required for similar classes of concrete."

REINFORCED CONCRETE BUILDINGS

In 1921, the Canada Cement Co. built a 10-story reinforced concrete office building with exterior of cast stone, in Montreal. It was specified that the concrete in the columns must show a strength of 3,000 pounds per square inch at 28 days and the concrete in the floor slabs, beams, etc., 2,500 pounds. In other words, this concrete was bought on a strength basis, as suggested in the Progress Report of the Joint Committee.

Table II contains a summary of the tests made on the concrete in this building. With one exception (the second test) the results were satisfactory, the average variation being less than ten per cent. Because of this one low strength test, a portion of the contract price was retained for some time until a satisfactory adjustment was made with the contractor. The results obtained in this building show the possibilities of requiring a definite strength in contracts for concrete buildings.

Fig 3—Reinforced Concrete Office Building of Canada Cement Co.

The slump test was used throughout this work to check the consistency of the concrete. It is interesting to note that a relatively stiff mixture was used, the average slump being only 4 in., the minimum being 2 in. and the maximum 8 in. Another interesting feature is the fact that the side walks were cured by being flooded with water for ten days.

MISCELLANEOUS

Among other cases where these principles have been applied successfully the following may be cited. Abrams' tables of proportions and quantities were used when Seventh Street, in Coeur D'Alene, Idaho, was paved with concrete in 1921.

The concrete developed a strength of 3,500 pounds per square inch at 28 days. The city engineer of San Diego, Calif., used these tables in constructing a dam and secured 3,000-pound concrete. The Chief Engineer of the Maricopa County (Ariz.) Highway Commission has also used these tables with excellent results. These principles are being applied on a 32-mile concrete road project in Washington County, Texas.

CONCLUSION

Thus modern scientific methods of proportioning, mixing and placing concrete have been applied in many cases with excellent results not only as to quality of concrete and use of available materials, but also as to total cost. In view of the results attained, it is hoped that these principles will soon come into general use on concrete work.

TABLE I. COMPRESSION TESTS OF FIELD CYLINDERS

HYDRO-ELECTRIC POWER COMMISSION OF ONTARIO
POWER HOUSE, CLASS B CONCRETE (2000 LBS. PER SQ. IN.)

Date Taken (1921)	Nominal Mix	Comp. Strength lbs. per sq. in. at 28 days	Date Taken	Nominal Mix	Comp. Strength lbs. per sq. in. at 28 days
May 9	1-1.83-3.66	2,655	June 16	1-1.83-3.66	2,775
May 16	1-1.83-3.66	2,435	June 21	1-1.83-3.66	3,750
May 19	1-1.83-3.66	2,322	June 23	1-1.83-3.66	2,785
May 26	1-1.83-3.66	2,680	June 29	1-2.44-4.88	1,927
May 30	1-1.83-3.66	2,499	July 1	1-1.83-3.66	2,280
June 2	1-1.4 -4.4	2,180	July 16	1-1.83-3.66	2,324
June 4	1-1.83-3.66	2,443	July 20	1-1.83-3.66	2,398
June 7	1-1.83-3.66	2,140	July 30	1-1.83-3.66	

POWER HOUSE, CLASS C CONCRETE (1500 LBS. PER SQ. IN.)

Date Taken	Nominal Mix	Comp. Strength lbs. per sq. in. at 28 days	Date Taken	Nominal Mix	Comp. Strength lbs. per sq. in. at 28 days
May 2	1-2.5 -5	1,253	June 18	1-2.44-4.88	2,420
May 5	1-2.5 -4.25	1,920	July 5	1-2.44-4.88	1,802
May 11	1-2.44-4.88	1,728	July 8	1-2.44-4.88	1,941
May 14	1-2.44-4.88	1,725	July 12	1-2.44-4.88	1,703
May 28	1-2.44-4.88	1,855	July 14	1-2.44-4.88	1,304
June 9	1-2.44-4.88	1,825	July 26	1-2.44-4.88	2,030
June 11	1-2.44-4.88	2,198	July 28	1-2.44-4.88	1,027
June 14	1-2.44-4.88	2,345			

TABLE II. SUMMARY OF TESTS ON CONCRETE USED IN CANADA CEMENT CO. BUILDING, MONTREAL, IN 1921, AS REPORTED BY J. T. DONALD & CO.

Date Made	Date Broken	Location	Compressive Strength	Average
July 15	Aug. 12	Sub. Basement Cols. S. E. Phillips Place	3060—2940—2990	2997
July 21	Aug. 18	E. Wall Foundation & N. E. Cols. No. 16	2530—2270—2040	2280
Aug. 19	Sept. 16	Four Front Cols. Sub. Basement	3300—3530—2980	3270
Aug. 25	Sept. 23	Walls & Cols. Basement Fl.	2830—3070—2920	2940
Aug. 31	Sept. 29	Cols. Basement to 1st Fl.	2940—2810—2880	2877
Sept. 16	Oct. 14	1st to 2nd Floor Cols.	2940—3080—2960	2890
Sept. 20	Oct. 18	2nd Floor—Slab	2860—2700—2630	2730
Sept. 23	Oct. 21	2nd Floor—Cols	2850—2880—3050	2927
Sept. 27	Oct. 25	3rd Floor—Slab	2630—2630—2570	2610
Sept. 28	Oct. 26	3rd Floor—Cols.	2730—2960—2820	2837
Oct. 6	Nov. 3	4th Floor—Cols.	2890—2980—2730	2866
Oct. 13	Nov. 10	5th Floor—Cols.	2520—2710—2610	2613
Oct. 15	Nov. 14	5th Floor—Slab	2720—2810—2790	2773
Oct. 19	Nov. 16	6th Floor—Slab	2600—2790—2630	2673
Oct. 21	Nov. 18	6th Floor—Cols.	2790—2780	2785
Oct. 26	Nov. 23	7th Floor (?) Floor—Slab	2720—2770	2745
Oct. 28	Nov. 25	7th Floor—Cols.	2700—2740—2770	2737
Nov. 2	Nov. 30	8th Floor—Slab	2670—2500	2585
Nov. 4	Dec. 2	8th Floor—Cols.	2980—2790—2760	2843
Nov. 14	Dec. 12	9th Floor—Cols	2750—3070—3270	3030
Nov. 16	Dec. 14	9th Floor—Slab	3460—2670—2700	2940
Nov. 22	Dec. 20	10th Floor—Slab	2500—2630—2420	2516
Nov. 23	Dec. 21	10th Floor—Cols.	2950—2790—2050	2930
Dec. 1	Dec. 29	Roof—Slab	2350—2670—2540	2520
Dec. 2		10th Floor—Cols.	2990—3530—3490	3337
Dec. 14		Penthouse—Slab	2420—2490—2510	2473
Dec. 15		Penthouse—Cols.	3530+3530+3530	3530
Dec. 20		Machy. Room—Cols.	3530+3530+3530	3530

Transmission Poles

Recent inquiry as to reinforced concrete transmission poles develops the information that they have been used with success in many cities by different corporations. In certain sections of Cleveland, the city ordinance prohibited the further erection of wood poles in 1915 and required also that all poles be removed within two years and wires placed below ground. There were already about 50 octagonal concrete poles in service in this city and these had promoted so much favorable comment that the company obtained permission to leave wires above ground provided concrete poles were installed. Concrete poles have largely replaced wood poles in outlying districts and are now being used in a great deal of new work.

In manufacturing transmission poles, the use of a relatively rich mixture is recommended in order to secure a strong concrete that will have the maximum resistance to bending stress to which transmission poles are subjected. It is suggested that proportions of one sack of portland cement to two cubic feet of clean, coarse sand, to three cubic feet of broken stone or pebbles, should under normal conditions give good results. The broken stone or pebbles should not be larger than 1½ in. if the pole is to be solid, or 1 in. in size if the pole is to be hollow. Just enough water should be used to secure what can best be called a "quaky" mixture; usually six gallons per sack of cement is sufficient. The concrete should be carefully worked into the forms and well tamped in order to prevent the formation of any air pockets or voids. An excess of water in the mixture is to be avoided; too rapid drying out of the concrete after it has been placed should be avoided. The presence of moisture is necessary in the concrete during the first few weeks after it has been placed in order to secure the maximum strength. Therefore, after the poles have hardened sufficiently after the removal of the forms, it is advisable to cover them with damp sand which should be kept moist for a period of two or three weeks.

The amount of reinforcement necessary and the exact dimensions of the pole will depend upon the load which the poles are to carry, viz., the number and size of the cross-arms and wires and the spacing of the poles. The wind pressure is a larger feature than the dead load.

Molds for transmission poles are not produced commercially. The Massey Concrete Products Corp., Peoples Gas Building, Chicago, produces molds for its own use in making poles by the centrifugal process under the trade name of "Hollow Spun." The Massey 20-ft. poles have a diameter at the top of 8¼ in. and at the butt of 13¼ in., weighing approximately 1720 lbs. for those of the greatest strength. Dimensions decrease for poles of less strength and down to a minimum for this length as follows: diameter at top 5¾ in., diameter at butt 10¾ in., weighing about 865 lbs.

Concrete Floors for Dancing

Perhaps the simplest and cheapest way to prepare an existing smooth, hard concrete surface for dancing is to treat it with liquid soap. The soap should be worked up into a lather and worked into the floor by means of a scrubbing brush, after which an occasional application of powdered soap to the floor will keep it in good condition. It may be necessary to apply several coats of the liquid soap, if the floor is somewhat rough and porous, before a smooth finish will be obtained suitable for dancing.

Another way is to treat the floor with a mixture of paraffin wax and turpentine. Both turpentine and paraffin wax should be of good grade and no more paraffin used than will be readily dissolved in the turpentine. Only enough of the mixture should be applied to the floor to thoroughly fill the pores. An excess of material would result in a sticky film on the surface. After the turpentine and paraffin wax have been allowed to dry, the surface should be treated with powdered wax, applied in the same manner as to an ordinary wooden finished floor.

A third method is to treat the floor with heated wax driven into the pores of the concrete by a machine similar to a blow torch. The permanence of this treatment will depend to a large extent on the penetration obtained for the heated wax and the penetration in turn will depend to a large extent on the temperature of the concrete. If it is possible to heat the concrete immediately preceding the application of the melted wax and to continue heating with a torch, the maximum penetration will be obtained. A satisfactory dancing surface may then be maintained by the application of wax used in the same manner as on a wooden dance floor.

Volume Production Means Higher Dividends for Block Makers

By E. W. Dienhart
Portland Cement Association
and Stanton Walker
Structural Materials Research Laboratory

Success, as measured in profits, in the manufacture of concrete building units, depends largely upon annual volume of sales. Volume is the governing factor in deciding whether a plant is going to make a total profit sufficient only to return a daily wage to its owner or one which will provide dividends on the invested capital and surplus sufficient to provide for expansion. Increased volume will materially reduce production costs and will require only a small additional capital investment.

Under the present conditions of the building material market, producers of concrete building units should make every provision for getting large volume production this year. An unprecedented building year is in prospect and the largest return will be to those who are prepared to deliver materials.

Concrete products manufacturers can best prepare for this condition by immediately operating their plants for two shifts per day. Taking an average plant operating 250 ton-hour days per year, producing 1200 block per day and assuming the costs and selling prices in the accompanying table, such a plant would show a profit of $15,000.

If the same plant operated throughout the year storing the block made in winter, ready for the spring and summer demand, a profit of $19,800 would result.

For greater volume the plant should be run double shift for the four months of building operations. Operating double shift will require a small additional investment for additional curing facilities in the plant not operating in the winter months. This will not be required in the plant operating throughout the year. The double shift will start with the approach of mild weather and curing time can be reduced to one-half of the winter curing period (provided the winter curing period was as long as should be); accordingly no additional curing facilities or equipment will be required.

That the increase in equipment is warranted is evidenced by the increased profit realized. The plant operated double shift four months of the year on a 200 total annual operating day basis would show a profit of $28,416, while the plant operated double shift for four months on the 300 total annual operating day basis would show a profit of $33,768.

Another way that most plants could increase volume and lower costs is by increasing the efficiency of their workmen. The average plant that produces 1200 block per day can be speeded up to as much as 25% greater production. The writers are familiar with plants throughout the country and of these there are a few outstanding ones where production in block per man-day is from 15% to 30% higher than other plants operating with similar equipment under similar conditions.

The effect that 25% increased production would have on a plant with an output of 1200 block per day operating 250 days per year is shown by comparing Table A with A-A. It shows a reduction in cost of 1.4 cents per block and an increased annual output of 75,000 block with an increased annual profit of $9,000.

It would be well worth while to pay one-half the cost saving for the hire of better skilled workmen, at a higher rate of pay, capable of obtaining the highest possible output of the machines used or in the shape of bonuses to present workmen as an incentive for maximum production or for overtime pay. The workmen would get increased pay while the plant operator would get lower cost and the all important increased volume. If one-half the savings in production cost

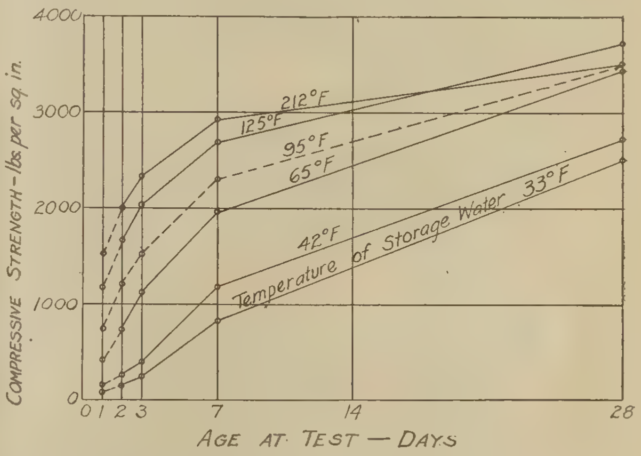


Fig. 1—Results of Tests Made at Structural Materials Research Laboratory by Prof. D. A. Abrams

Note: Curves Projected to Left to Show Approximate Strength at 1 Day; 95% F Curve Estimated

Concrete 1 day old cured for 24 hrs. at 125° F., is the same strength as concrete 3½ days old cured at 65°.

Concrete 1 day old cured for 24 hrs. at 125° F., is three times as strong as when cured 24 hours at 65° F.

Concrete 3 days old is twice as strong when cured for 72 hrs. at 125° F. as when cured for the same period at 65° F.

Concrete cured at 125° F. for 3 days is 66% stronger than when cured at the same temperature for 1 day. Concrete cured at 125° F. for 2 days is 37½% stronger than when cured at that temperature for 1 day.

Concrete 3 days old cured for 3 days at 125° F. has the same strength as concrete 7 days old cured at 65° F.

were passed on to the workmen there would then remain an increased annual profit of $6,375.

Curing Concrete Products

With the certain tremendous demand for block the coming year, the products manufacturer will be confronted with a difficult curing problem. During the peak months of construction activity, builders and contractors are going to clamor for materials and many products men are likely to supply block only a few days old which they know are green and should not be built into a wall until they have had a chance to cure.

Many products men will risk their reputations for turning our first class products because they feel that if *they* don't sell the particular job at hand somebody else, with no scruples about the quality of his product, *will* sell the job.

There is no need for this. If a conscientious manufacturer has depleted his stock to a point where orders are ahead of production he can hasten the curing period of his products either by the use of steam curing (where a plant now does not steam cure) or by longer steam curing (where a plant now uses that method).

Tests made by the Structural Materials Research Laboratory show the effect of curing temperature on the strength of concrete. The results of these tests are indicated by Fig. 1.

The diagram is based on compression tests of 6 x 12-in. concrete cylinders, using a 1:4 mix, aggregate graded up to 1½ in. It is believed that the results of these tests will apply to the conditions encountered in the usual products plant.

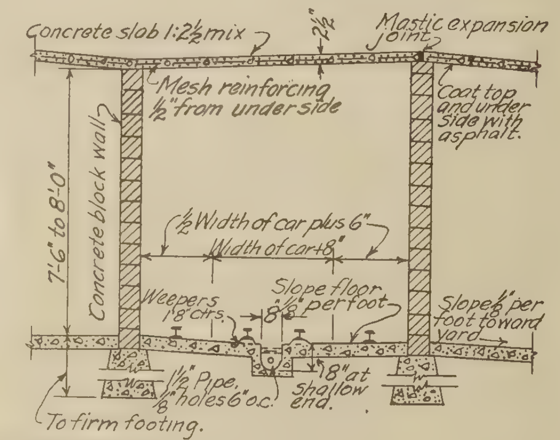
The curves have been projected to the left in order to show the approximate strength of the concrete at 1 day. The curve for 95° temperature was also estimated by averaging the two adjacent curves.

The diagram brings out the following facts on concrete made with all conditions, except curing temperature, identical.

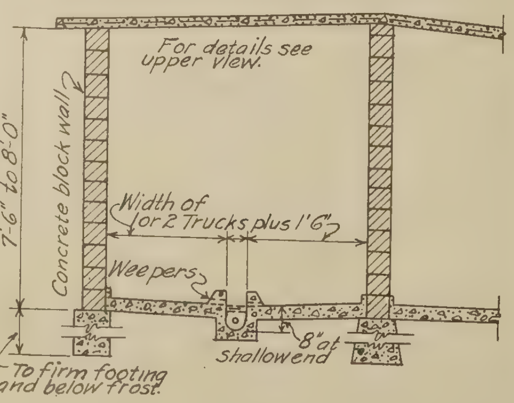
These diagrams show that high curing temperatures increase the strength of concrete materially during the first 3 days. They show the way out to the products manufacturer who wants to maintain high quality during the period when his production cannot meet the demand.

It is important to remember that while heat hastens the hardening of concrete, it is beneficial only so long as the products are cured under a condition in which the air is saturated with moisture. If high temperatures are applied to green concrete without plenty of water being introduced into the curing room, the heat will *do more harm than good* because it will dry out the all-important mixing water from the concrete. Water can be introduced into the curing room either by condensed low-pressure steam, fog, or spray nozzles or compressed air atomizers.

The latest in curing room equipment calls for regular steam coils for heat and a separate system of pipes for



SECTION THROUGH TUNNEL ARRANGED FOR CARS ON RAILS.


For details see upper view.
Concrete block wall
7'-6" to 8'-0"
Width of (or 2 Trucks plus 1'6"
Weepers
8" at shallow end
To firm footing and below frost.

SECTION THROUGH TUNNEL ARRANGED FOR LIFT TRUCKS

Fig. 2 (Above)—Section Through Tunnel Arranged for Cars on Rails. (Below)—Section Through Tunnel Arranged for Lift Trucks

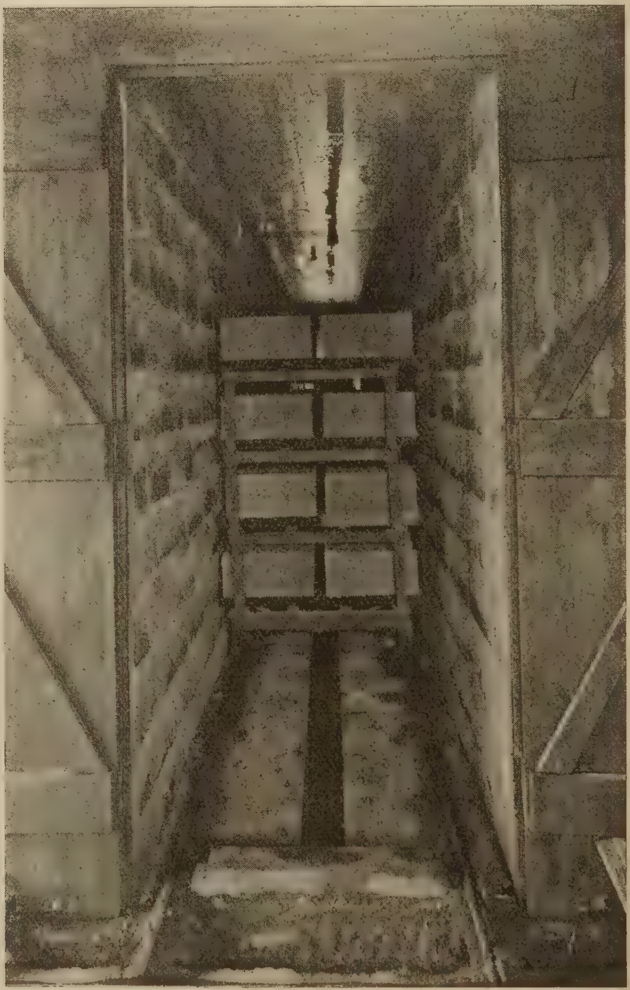


Fig. 3—Steam Curing Room Built Narrow and Low with Tight Fitting Doors so as to Conserve Heat

Note: Steam Pipe in Trough Kept Filled with Water

water with atomizer nozzles. This system is economical to maintain, requiring a minimum of coal for heating. It also permits of regulating the moisture in the curing rooms to any required degree.

During the period of exceptional demand there is also a way out for the manufacturer of products who does not have steam-curing facilities. While he cannot expect the same degree of efficiency that steam-curing provides, he can cure his products so as to get maximum concrete strength possible by the air-curing method.

Fig. 4—The St. Paul Cement Works, St. Paul, Minn., Keep Block in Storage Pile Saturated in Addition to Steam-Curing for 24 Hours

Concrete continues to gain in strength indefinitely so long as it is kept moist; it ceases to gain in strength if it dries out. The strength of concrete of a given mix depends primarily upon the condition of curing during the period directly after it is made. *The concrete products manufacturer without steam-curing facilities should keep his products saturated with water until they leave his yard.*

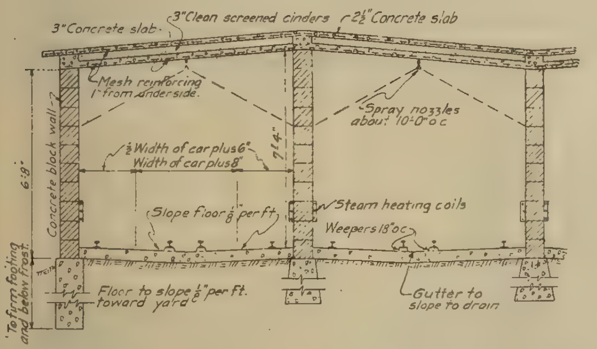


Fig. 5—Details of Typical Curing Room with Steam Coils on Walls and Spray Nozzles in Ceiling

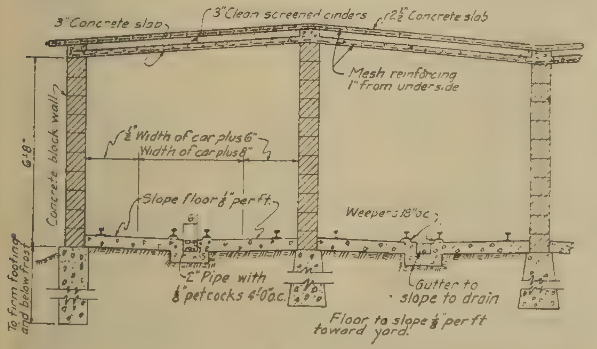


Fig. 6—Typical Curing Room with Perforated Steam Pipes Laid in Trough Filled with Water

Higher strengths of concrete at early ages can also be obtained by increasing the cement content of the mix. Under favorable conditions of curing where the block are cured at a temperature of 70° F. or more and kept moist, the following comparisons of strength can be expected:

Concrete *1:5 mix* will be the *same strength at 7 days* as *1:7 mix at 28 days.*

Concrete *1:3 mix* will be the *same strength at 2 days* as *1:7 mix at 28 days.*

Concrete *1:3 mix* will be the *same strength at 6 days* as *1:5 mix at 28 days.*

Concrete *1:5 mix* is *twice as strong at 7 days* as *1:7 mix at 7 days.*

Concrete *1:4 mix* is nearly *three times as strong* at *7 days* as *1:7 mix at 7 days.*

Under no circumstances should concrete products be shipped from the plant until they are of sufficient strength to meet the required standards of the American Concrete Institute or the building code requirements of the city where they are to be used.

SUMMARY OF PLANT OPERATION
1200 Block Per 10-Hour Day Capacity

		Cost per Block		
A				
1200 block per day	(Cement	.037		
Single shift 10 hrs.	(Aggregate	.03		Annual Output
250 operating *days*	(Labor	.018		300,000 block at
Annual sales and	(Direct Mfg. Expense	.008		19¢ each=$57,000
overhead expense	(Mfg. overhead expense	.017		
$9,000.00				
	(Mfg. Cost per Block		11.0¢	
	(Sales Expense		3.0	*Profit—$15.000*
	Total Cost per Block		.14¢	
B				
2400 block per day	(Cement	.037		
Double shift for	(Aggregate	.03		Annual output,
120 days	(Labor	.018		444,000 block at
1200 block per day	(Direct Mfg. Expense	.008		19¢ each=$84,360
Single shift for	(Mfg. overhead expense	.011		
130 days	*(Int. on $5500 (1 yr.)	.001		
Annual sales and	*(Int. on $4000 (4 mo.)			
overhead expense				
$9,500.00	(Mfg. cost per block		10.5¢	
	(Sales expense		2.1¢	*Profit—$28,416*
	Total cost per block		12.6¢	
C				
1200 block per day	(Cement	.037		
Single shift 10 hrs.	(Aggregate	.03		Annual output,
300 operating *days*	(Labor	.018		360,000 block at
Annual Sales and	(Direct Mfg. Expense	.008		19¢ each—$68,400
overhead expense	(Mfg. overhead expense	.014		
$9;000.00	*(Int. on $5500 for 1 yr.)	.002		
	*(Int. on $15000 (4 mo.)			
	(Mfg. cost per block		10.9¢	
	(Sales expense		2.5	*Profit—$20,160*
	Total cost per block		13.4¢	
D				
2400 block per day	(Cement	.037		
Double shift for	(Aggregate	.03		Annual output,
120 days	(Labor	.018		504,000 block at
1200 block per day	(Direct Mfg. Expense	.008		19¢ each=$95,760
Single Shift for	(Mfg. overhead expense	.01		
180 days	*(Int. on Add. capital	.001		
Annual sales and	(Mfg. cost per block		10.4¢	
overhead expense	(Sales expense		1.9	*Profit—$33,768*
$9,500.00				
	Total cost per block		12.3¢	
A-A.	Effect of 25% Increased Labor Efficiency			
1500 block per day	(Cement	.037		
Single Shift 10 hrs.	(Aggregate	.03		Annual output,
250 operating days	(Labor	.014		375,000 block at
Annual sales and	(Direct Mfg. Expense	.007		19¢ each—$71,250
overhead expense	(Mfg. overhead expense.....	.013		
$9,500.00				
	(Mfg. cost per block		10.1¢	
	(Sales expense		2.5	*Profit—$24,000*
	Total cost per block		12.6¢	

*Interest charges on investment for increased curing facilities and additional operating capital.

Note—Manufacturing overhead covers depreciation of buildings and machinery, interest on investment, taxes, insurance and land rentals.

International Road Congress

The fourth International Road Congress will open at Seville, Spain, May 7, 1923. The chief subjects to be discussed are the surfacing of roads with concrete, use of bitumen and asphalt for surfacing, laying tramway-rails on the various kinds of surface, mechanical equipment progress, development of motor transport, and general traffic regulations.

Concrete in Remodeling for Denver School

By A. J. R. Curtis

The recently completed Cathedral High School and Convent at 19th and Grant Streets, Denver, Colo., is a pleasing and noteworthy example of Spanish-Gothic architecture so much desired in western ecclesiastical and educational structures. The attractive group was obtained by remodeling an imposing old brick residence and a two-story brick barn which formerly occupied the site. New walls (required to supplement portions of the old walls) were constructed of concrete and brick. A generous use has been made of concrete stone, including sills, lintels, columns, balustrades, symbolical placques and statues. A great deal of this work is of intricate design, requiring exacting detail in its production. Concrete cast stone was also used throughout the interior. The texture is fine, resembling bedford stone, while the color is a cream-white, contrasting mildly with the beautiful cream colored portland cement stucco used as an exterior finish. Imperial Spanish tile, dull red in color, are used on the roof.

The building has reinforced concrete floors and staircases, and is of fireproof construction throughout. Seldom will there be found anywhere in a single structure examples of concrete used by such a variety of methods or combined so well with old brick construction. The architect, H. J. Manning of Denver, displayed no small measure of ingenuity in adapting a very beautiful design to local circumstances, devising the methods used as a means of keeping down cost without skimping on quality anywhere. Construction was handled by Charles J. Dunn, a local contractor, at a total cost of $135,000.

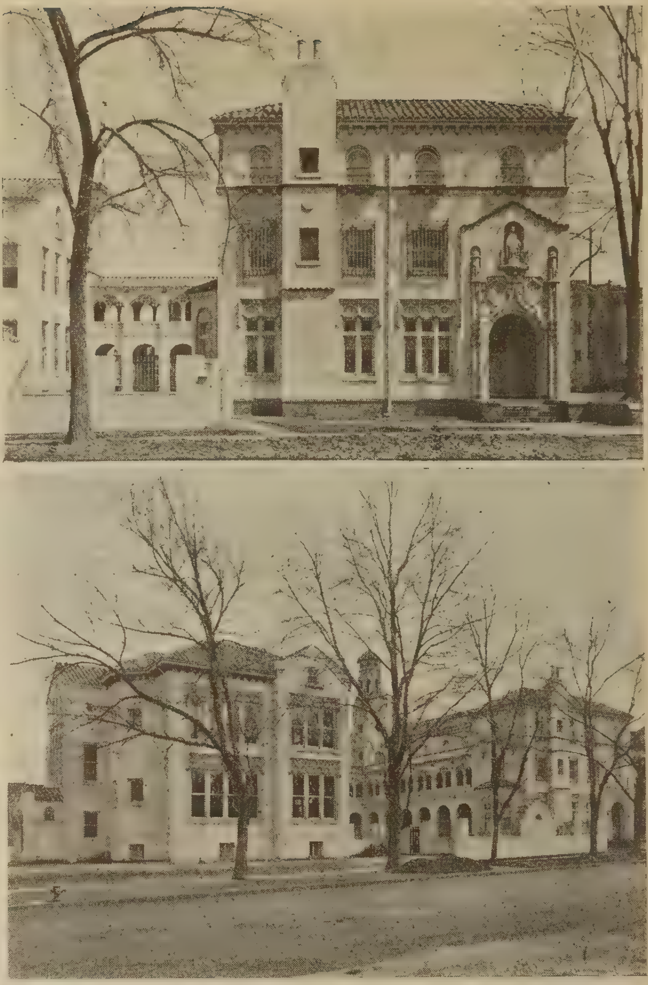


Fig. 1—General Views of Completed School Group, Denver Cathedral High School

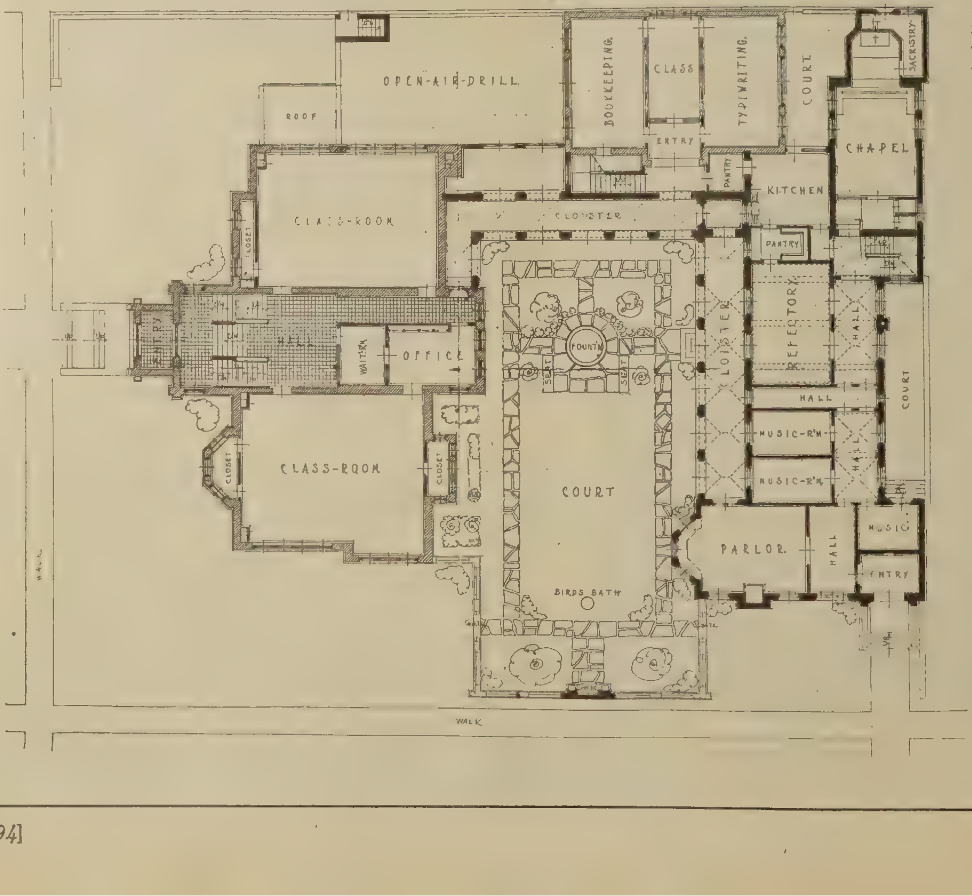


Fig. 2—Plan Showing Layout of Buildings Around Court

Concrete Brick Make Stronger Masonry

(Continued from page 172)

For concrete brick piers the relation between the ultimate compressive strength of the pier C and the ultimate compressive strength of the brick B is that of a flat curve passing through the origin of coordinates which can be expressed by the following exponential equations:

For the concrete brick, Series A

$$C = 6.22\ B^{0.72}$$

For the concrete brick, Series B and C

$$C = 5.5\ B^{0.72}$$

A similar relation undoubtedly exists for the sand-lime brick and clay brick series. The test data available cover too small a range and the individual test results show a degree of variation which makes it impossible to determine the exact law of variation between the compressive strength of the masonry and the compressive strength of the brick for such materials. A straight line drawn through the origin of coordinates coinciding with the mean test results seems to fit the test data quite closely.

The equations of such straight lines are:

For clay brick, Series A

$$C = 0.424\ B$$

For clay brick, Series B and C

$$C = 0.245\ B$$

The difference in strength between concrete brick masonry and clay brick masonry at the age of 30 days is further shown in the following table. The values given have been determined from the curves in Diagram 3 (Fig. 4).

Ultimate Compressive Strength of Brick in lbs. per sq. in.	Ultimate Compressive Strength of Pier in lbs. per sq. in.			
	Concrete Series		Clay Brick Series	
	A	B and C	A	B and C
1500	1210	1070	....	....
2000	1490	1320	850	490
3000	1970	1760	1270	740
4000	2450	2170	1700	980
5000	....	....	2120	1220

CHARACTER OF FAILURE

The behavior of concrete brick masonry and clay brick masonry under compressive loads at or near the ultimate load was found to be different. The concrete brick piers failed in general in diagonal shear, the resultant fractures resembling very closely the characteristic fractures obtained with monolithic concrete piers.

In general, failure in these clay brick piers (Plate 5 of original report—Fig. 8 of this abstract) occurred not as in a monolithic unit, but appeared to be a progressive disintegration of the individual brick units and of the mortar and bond between them. It was further noted that the disintegration of one or several of the brick units in the body of the masonry sets up a high lateral pressure in all directions which resulted in a pronounced lateral expansion of the cross-section, a secondary failure which became more pronounced as failure progressed.

Upon the surface of these piers (sand-lime brick piers No. 65, 68, 71), formed by the light-colored regular-shaped brick with their sharp arrises, the progress of failure is recorded in an interesting

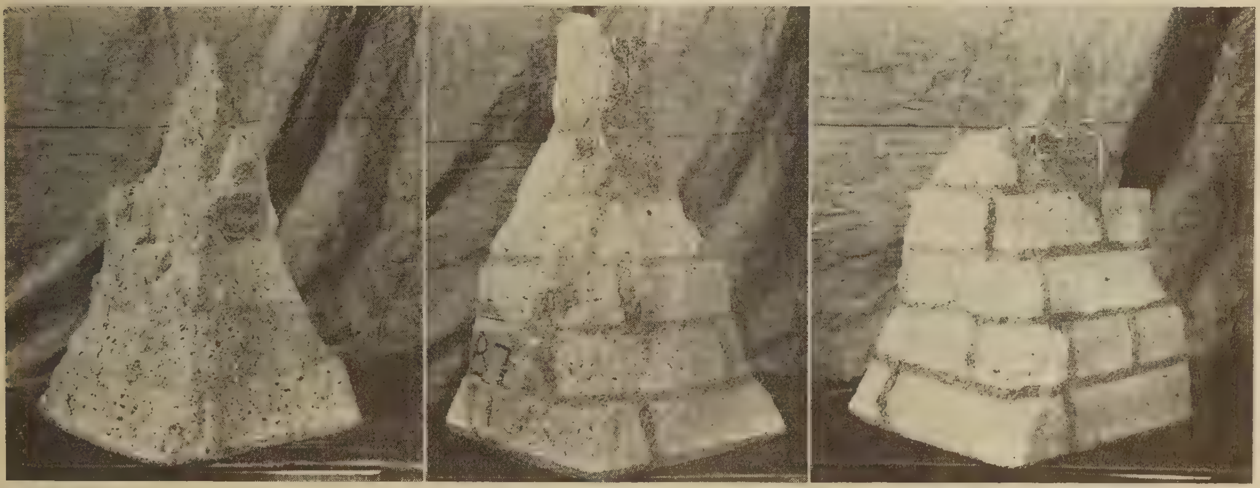


FIG. 8 (UPPER)—(PLATE 4 OF REPORT)—TYPICAL FRACTURES OF CONCRETE BRICK PIERS

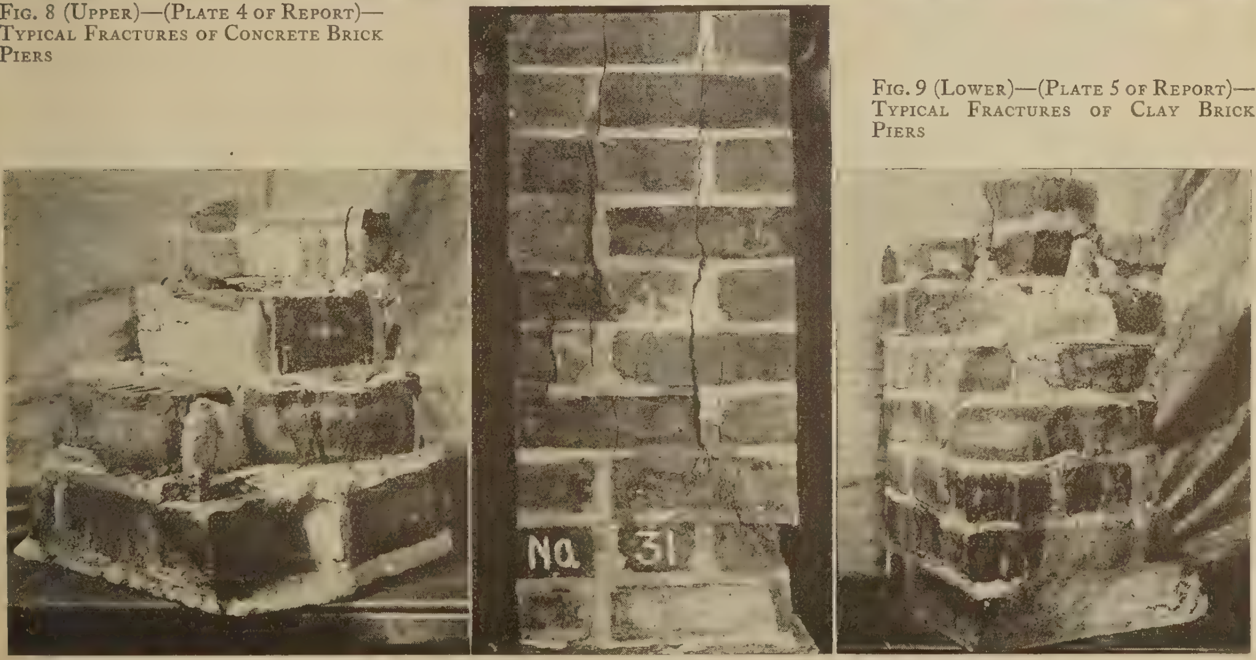


FIG. 9 (LOWER)—(PLATE 5 OF REPORT)—TYPICAL FRACTURES OF CLAY BRICK PIERS

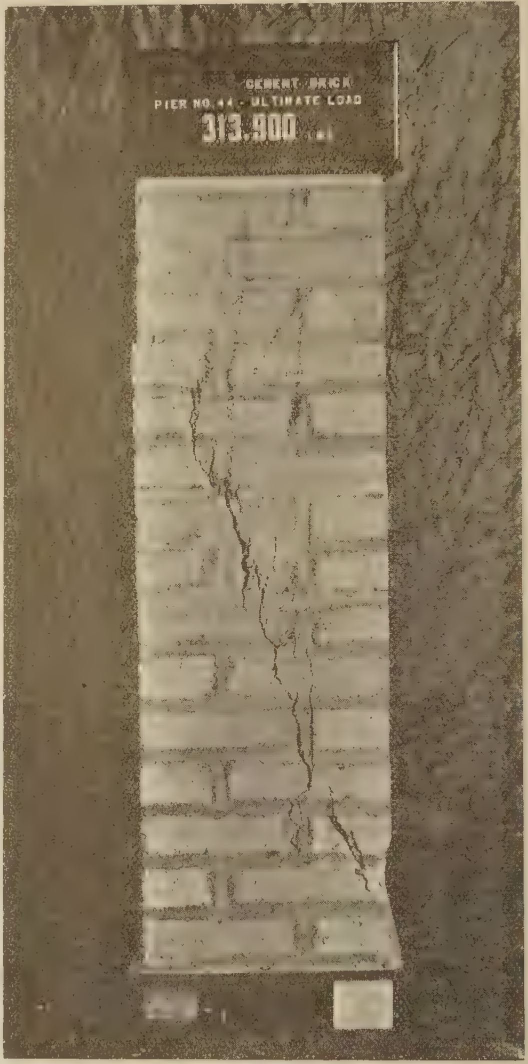


Fig. 10—(Part of Plate 3 of Report)—Typical Failure of Concrete Brick Pier

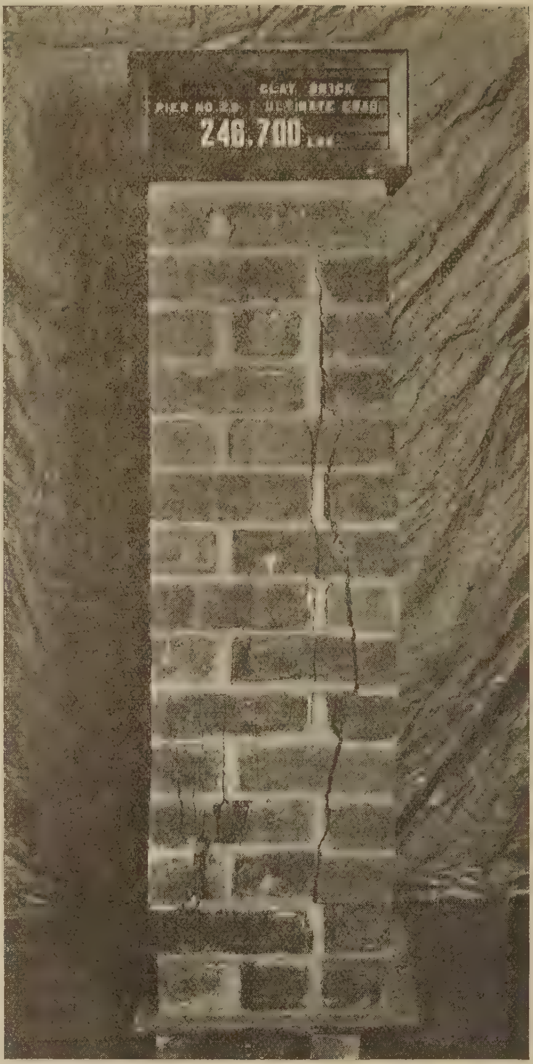


Fig. 11—(Part of Plate 7 of Report)—Typical Failure of 40-in. Clay Brick Pier

manner. The first visible surface sign of incipient failure was the formation of a fine hair crack between the vertical face of a brick and the mortar; many such cracks are clearly shown upon these photographs. All of them developed as a result of the lateral swelling or expansion which in all materials accompanies an axial compressive load. As soon as one formed, high secondary stresses, of sufficient intensity to fracture adjacent bricks, were set up in the masonry in the vicinity of such a crack. As these vertical cracks increased in number and magnitude, more and more irregular stress distributions were set up, and bricks, which normally in a well-bonded masonry are subjected to compressive stresses only, now had to carry heavy loads in flexure, which resulted in progressive failures of the individual bricks.

Near the ends of the piers the adhesion of the mortar to the steel plates, assisted by friction, prevented to a very large extent the lateral expansion and swelling of the pier. The actual bond stresses developed between the bricks and mortar at the ends of the pier were insufficient to cause bond failures, as is clearly recorded upon the surface of these piers.

In concrete brick piers, failure by diagonal shear is usually the controlling factor, especially with concrete bricks of average strength. Under certain conditions when concrete bricks of very high compressive strength are used, the bond strength between bricks and mortar may not be sufficient to develop the full monolithic strength of the masonry, and the type of failure characteristic of insufficient bond strength becomes evident.

The effect of adequate bond between mortar and brick, both upon the strength of the pier and the type of failure, is further illustrated by concrete brick Piers 19 and 20.

The concrete bricks used were 250 days old at the time Pier No. 19 was tested and showed no increase in strength when Pier No. 20 was tested 64 days later. There was however, a decided increase in mortar strength with age as follows:

No. of Pier	Compressive Strength of Brick	Compressive Strength of Mortar	Compressive Strength of Pier
19	2678	2377	1832
20	2610	3206	2078

All strength is expressed in pounds per square inch.

Pier No. 20 behaved exactly like a monolithic concrete pier, whereas in Pier No. 19 the lack of bond strength is apparent. This is evident from the vertical crack developed in one of the faces and from the pronounced vertical and horizontal cleavage planes developed in line with mortar joints.

The increase in pier strength with age as compared to increase in mortar strength with age is as follows:

	Compressive Strength of Mortar, lbs. per sq. in.		Percentage of Increase in Strength	
	30 Days	90 Days	Mortar	Pier
Concrete Brick Piers	2336	2641	13.1	15.8
Clay and Sand-lime Brick Piers.......	2447	2695	10.2	13.0

Effect of Height of Pier upon Pier Strength

The investigation of the effect of height of pier upon its strength was limited to two heights, namely, 40 in. and 84 in. The results are of value in pointing out that the loss in strength with height is not only a function of the height but also depends upon the kind of masonry. The results show that the clay brick piers, both at 30 and 90 days, are materially reduced in strength as the height of pier is doubled.

Height of Pier in Inches	Ratio of Compressive Strength of Pier to Brick		Compressive Strength of Mortar, lbs. per sq. in.	
	30 Days	90 Days	30 Days	90 Days
40	0.424	0.48	2250	2560
84	0.38	0.43	2680	2810
Ratio 84:40	0.90	0.90	1.19	1.10

NOTE: Defective specimens have been omitted in computing the above average mortar strengths. The results of the tests of the sand-lime brick piers have been included in the summary as their behavior was similar to that of the clay brick piers.

A similar comparison for the concrete brick piers is as follows:

Height of Pier in Inches	Compressive Strength of Pier in Terms of Compressive Strength of Brick, lbs. per sq. in.		Compressive Strength of Mortar, lbs. per sq. in.	
	30 Days	90 Days	30 Days	90 Days
40	$6.22B^{72}$	$7.2B^{72}$	2340	2640
84	6.22B	$7.2B^{72}$	2500*	2650
Ratio 84:40	1.00	1.00	1.07	1.00

Average mortar strength does not include low mortar strength obtained for Pier No. 59.

On the assumption that the test data have been correctly interpreted, the only conclusion that can be reached is that the loss of strength with increase in height is greater in clay brick masonry than in concrete masonry. The 84-in. concrete brick piers showed no appreciable loss in strength as compared to the 40-in. piers, both at the age of 30 days and 90 days. The clay brick piers, on the other hand showed a 10% lower strength for the higher piers, both at the age of 30 and 90 days.

The appreciable loss in strength with height of pier found in the clay brick piers is a direct result of the characteristic failure of such masonry, namely, insufficient bond strength between mortar and bricks, resulting in detail and not in unit failure. The longitudinal splitting of the pier, a direct result of bond failure, increases the tendency of long column failure in the 84-in. piers and materially reduces their resistance to compressive loads.

This tendency of clay brick piers to split is guarded against in practice by using bond stones of the full cross-section of the pier at frequent intervals. In concrete brick masonry it would appear that bond stones are not as necessary, as such masonry does not in general fail in detail but as a monolithic unit.

THE ELASTIC LIMIT OF BRICK MASONRY

For both the clay and sand-lime brick piers the ratio of elastic limit to ultimate strength was found to be 0.47; for the concrete brick piers, 0.57; and 0.52 for the monolithic concrete piers. The high ratio values secured with concrete brick and monolithic concrete piers may in part be due to the manner of failure. These piers failed as units, whereas the clay and sand-lime brick piers failed in detail, detail failure starting at proportionately much lower stresses than unit failure.

A comparison of these piers upon the basis of elastic limits is as follows:

Ultimate Compressive Strength of Brick, lbs. per sq. in.	Elastic Limit of Masonry, lbs. per sq. in.	
	Concrete Series A	Clay and Sand-lime Series A
1500	690	....
2000	840	....
3000	1120	590
4000	1390	800
5000	....	990

Assuming average conditions, a concrete brick having an average compressive strength of 1500 lbs. per sq. in. will, if laid in 1:3 portland cement mortar, form a masonry which will have an average compressive strength of 1210 lbs. per sq. in. and an elastic limit of 690 lbs. per sq. in.; a clay brick of a compressive strength of 3000 lbs. per sq. in. will develop in the form of masonry under identical conditions an ultimate compressive strength of 1270 lbs. per sq. in. and an elastic limit of 590 lbs. per sq. in.

MODULUS OF ELASTICITY OF BRICK MASONRY

The moduli of elasticity of all of the masonry piers in Series A were determined as previously described. The average moduli of elasticity for the piers composed of the various kinds of brick are as follows:

Series	Kind of Brick	Modulus of Elasticity, lbs. per sq. in.	
		30 Days	90 Days
A-I	Clay	822,250	1,025,500
A-II	Clay	1,563,000	1,627,500
A-III	Clay	1,165,000	1,325,000
A-IV	Clay	1,336,250	1,295,000
A-V	Sand-lime	1,584,500	1,746,250
	Average	1,294,200	1,403,850
A-VI	Concrete	1,317,500	1,383,000
A-VII	Concrete	2,035,000	2,059,500
A-VIII	Concrete	1,636,750	1,507 500
A-IX	Concrete	1,995 500	1,775,000
A-X	Concrete	1,681,250	1,565,750
	Average	1,733,200	1,658,150
	Monolithic Concrete	2,910,000	3,405,000

A comparison of these moduli with the corresponding compressive strengths of the piers indicates in general an increase of the modulus with the compressive strength. The data, however, do not permit of formulating any definite law expressing this variation.

A Concrete Illustration

Nowhere is it more necessary to sugar-coat educational material and make it so that he who runs may read, than at state and county fairs. A Montana representative of the Portland Cement Association arranged an exhibit for the State Fair last fall that would attract attention, speak for itself, and furnish its quota of amusement to an amusement-seeking public.

This was a miniature farm with concrete buildings, walks and roads. There was a stuccoed house, a barn, chicken house and garage. At the rear of the barn was a concrete silo and a feed lot floored with concrete; the walks were of concrete and a well constructed concrete road ran in front of the farm.

By way of comparison, on one side of the farm a tiny truck struggled through a gumbo road, trying vainly to pull a load of corn.

Trees, green lawn, toy autos, animals and dolls completed the display, making it so alluring that children insisted on pausing, thus compelling the most indifferent parents to stop and learn the gospel of concrete.

The entire exhibit can be boxed and shipped from one place to another and at this writing has been a feature of three fairs and three corn shows, and of a store window in Butte.

White Ants Didn't Destroy Concrete

Some time ago a Chicago newspaper published a story about depredations of white ants at Clinton, Ill. Millions of white ants were said to be threatening the destruction of houses in Clintón, Ill., even attacking and destroying concrete block.

An investigator found on a close survey of the concrete block on the premises of C. T. Sprague who has been *the only one molested*, that the ants had *not* been able to honey-comb the block as stated in the news article. Several blocks had been removed near the cellar door as it became necessary to do this in order to apply chemicals around the joists and other parts where the ants were eating into the wood. These block show no signs of being attacked. They do, however, show where the ants have been working, but by removing the dirt from the blocks it is found they are as smooth as ever. Mr. Sprague had to remove all of the siding around the house up to the sill of the windows, and a great deal of the flooring in the house in order to get at the ants.

Modern Developments in Maintaining Concrete Pavements

By Leroy C. Smith

Engineer-Manager, Board of County Road Commissioners of Wayne County, Michigan

It is usual to figure maintenance and depreciation of a building at the rate of 2 to 4 percent annually, and in defense of the maintenance cost of pavements, especially concrete, I should like to record the fact that I have no knowledge of any concrete pavement costing a greater amount than that for its maintenance.

The better the road is built, the less maintenance charge there will be against it. Roads built ten years ago with a maximum thickness of six inches—before better practice had been established in the methods of constructing concrete pavements—are the ones that are today requiring the greatest expenditures for maintenance. In the early development of the concrete road insufficient allowance was made for the probable increase in traffic in our industrial districts, and the optimism of the public official and engineer was too great as to the sustaining strength of a concrete slab with a 6-in. maximum thickness.

Three-quarters of the maintenance activities on concrete pavements in any community are directly attributable to the above causes. Maintenance costs are also directly in proportion to the intensity of traffic and the weight of loads, and the roads which require the greatest amount of maintenance are those which have become inadequate both in thickness and width. Table I covers the maintenance costs for 1922 of cement-concrete pavements in Wayne County, Michigan.

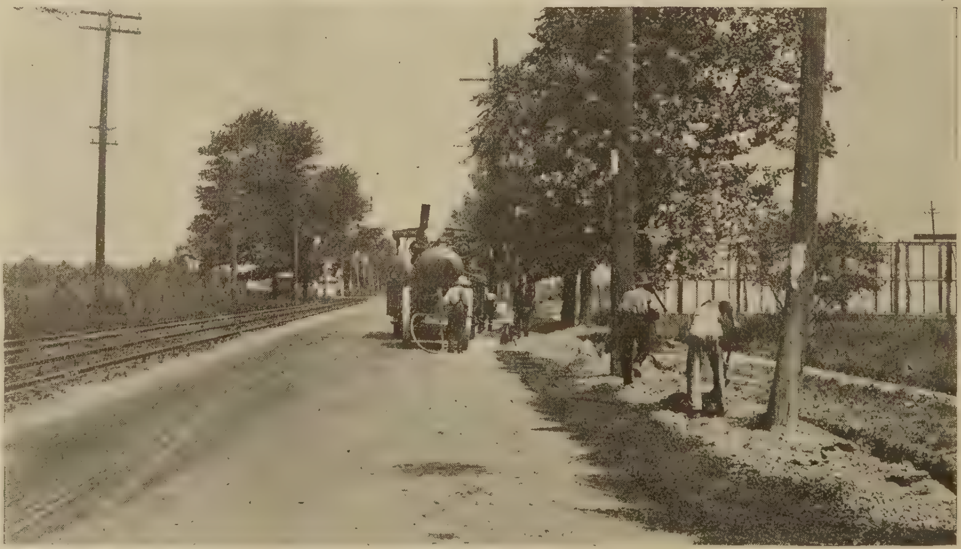
Thoroughfares upon which we should have 60-ft. pavements, lowered to city grades, with under-drainage, are still being maintained by us as 16- and 18-ft. concrete roads, all of them being not more than six inches in thickness. These roads are now carrying traffic of from five to ten thousand vehicles per day. Such roads as this attract attention owing to the excessive cost of maintenance while in reality they are not a fair criterion of the proper cost of maintenance of concrete pavement. We are prone to forget the thousands of miles of concrete pavement which have been laid during the past ten years in sections where the industrial and traffic development has not been so great and where the road has proved adequate not only in thickness, but in width, and has given excellent service.

Features of Maintenance Not Included

In order to reduce this paper to the exact subject outlined in the title, we will exclude discussion of the many items of maintenance applicable to all types of road. The items I refer to are: shoulders, many of which must be macadamized temporarily, the best results being with penetration macadam; ditches, which have to be maintained upon any road; guard rail; culverts; cutting weeds; erecting and maintaining signs; snow removal; and roadside development, which in my opinion is one of the coming features in the cost of maintenance of any road system.

By eliminating the above, we reduce the discussion to the maintenance of the concrete pavement proper. This involves the tarring or asphalting of cracks and

Fig. 1—Macadamizing Shoulders of Road as Temporary Maintenance. Trailer with Hot Tar in Use



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[1] Presented at the Ninth Annual Michigan Conference on Highway Engineering, Feb. 14, 1923, at the University of Michigan, Ann Arbor.

Table I. Maintenance Costs for 1922 of Cement-Concrete Pavements for Various Roads in Wayne County, Michigan*

Name of Road	Length	Age Average of Sections	Cost of Tarring	Cost of Concrete Patching	Mile	Average Traffic Per Day	Cost per Vehicle Mile
Huron River Drive	25.5	8	$ 759.00	$1016.00	$ 69.00	414	$0.00084
Warren Avenue	22.0	3	2261.00	1413.00	167.00	1398	0.00060
Seven Mile Road	31.1	7	3586.00	9523.00	422.00	1482	0.00140
Mack Avenue	7.5	6	284.00	673.00	127.00	2040	0.00031
River Road	12.5	11	3860.00	2707.00	525.00	3930	0.00067
Michigan Avenue	20.7	11	5779.00	4760.00	509.00	4812	0.00052
Gratiot Avenue	4.3	7	1136.00	849.00	462.00	5200	0.00044

*Notes: These figures are based on a 14-hour traffic count per day. Calculations are based upon a 200-day year. Cost per mile does not include maintenance of shoulders, ditches, guard rails and culverts.

joints, and concrete patching where a considerable area of the pavement is broken down.

In the maintenance of concrete roads the old adage "A stitch in time saves nine" is applicable, and, as usual, too many of us are making speeches about the importance of continuous, adequate and prompt maintenance, and after making the statements we return home and neglect the maintenance, sometimes by reason of the lack of funds to carry out the program or through poor organization or dilatory methods in caring for the work.

It is my opinion that a great number of serious breaks in concrete pavements can be prevented by a thin application of tar and sand or, if the depression or abrasion is one-half inch deep, by the use of small granite chips, to mend the surface before heavy trucks have an opportunity to jar over the uneven places and by their impact shatter additional sections of concrete. The Bates road tests impress this point upon our minds: that where a slight break appears at a corner near the edge of a pavement, the failure of the pavement is rapid and progressive from that point.

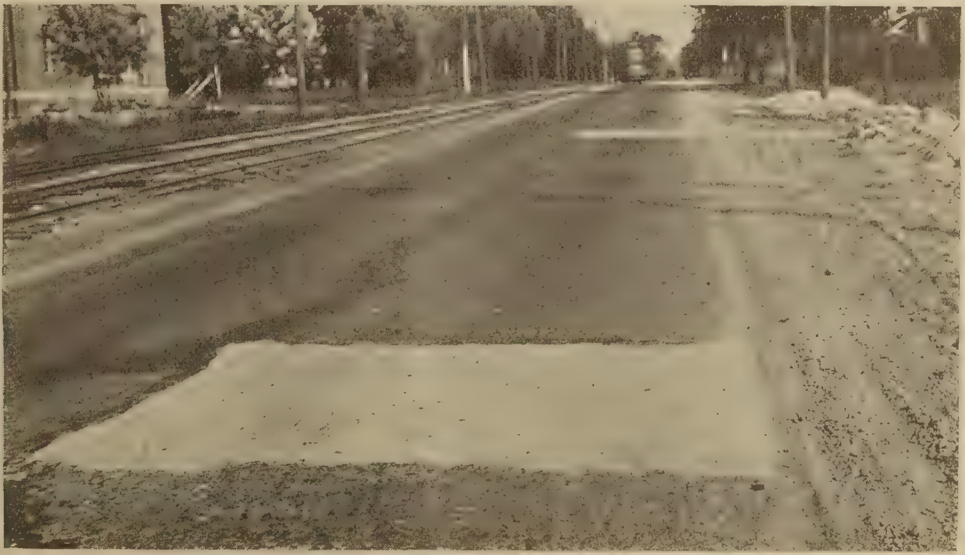
Repairing Cracks and Joints

Three or four times a year it is necessary and desirable to distribute and apply small quantities of tar or asphalt in the cracks, joints and small abrasions in the surface of the pavement. The usual and old method of doing this work was to send out a few barrels of the bituminous materials and distribute it along the line of road in approximately the proper amounts to take care of the application which is expected to follow at an early date. Then what is known as a "tar gang," consisting of about half a dozen men, with a two-barrel tar kettle on wheels, comes down the road, opens up the barrels with difficulty, puts the tar in the kettle, builds a fire with the staves and some of the tar adhering to them and, after an hour or two, when they get the tar to what the foreman considers the proper heat, applies the material to the cracks and joints where needed. This method is expensive both in labor and material, involves the destruction of the barrels in which the tar was delivered and, worst of all, makes for delay and inefficiency in labor. Such conditions must be the usual practice for any communities having but a small amount of concrete pavement to maintain. They are, however, being corrected where large mileages of concrete pavement must be maintained.

Central yards are being established in convenient locations to supply materials for maintaining 100 to 150 miles of concrete road. These yards are adjacent to railroad sidings, so that tar may be purchased in tank-carlots. From the tank-cars it is pumped, or blown by air, into elevated storage tanks of 15,000 gallons capacity. These tanks are provided with steam coils for heating the tar, and insulated so as to hold the heat. Five-ton motor trailers are provided which will hold from eight to ten barrels. The trailers are provided with kerosene heaters, to keep the tar at the proper temperature during the entire day.

The work is so organized that a night watchman heats the tar, fills the trailers and prepares the equipment for use on the following day. In the morning, a tarring gang is able to start out from this central yard with a truckload of dry sand, granite chips and a 10-barrel trailer of hot tar, ready to go to work. It

Fig. 2—Typical Example of Concrete Patching, Wayne County Road



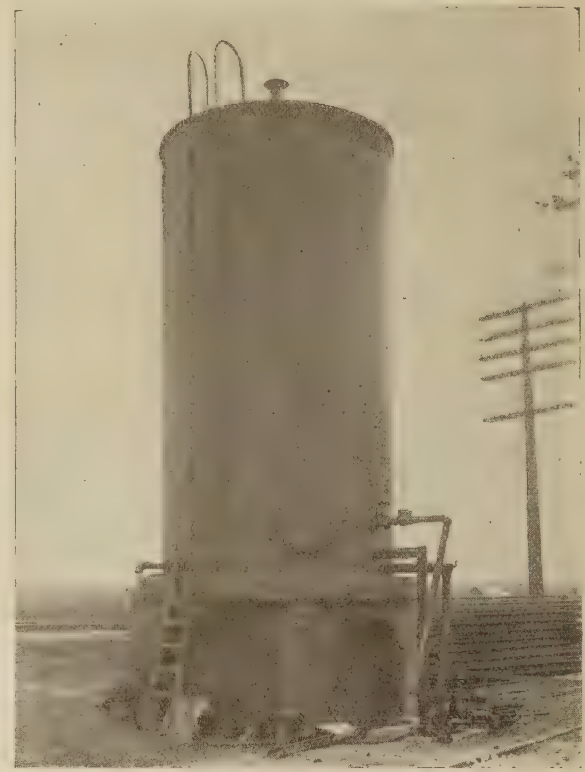


Fig. 3—Tar Tank at Wayne Shops. Elevated Storage Tank Provided with Steam Pipes for Heating Tar

has been found that the equipment as outlined is of about the right capacity to supply a tarring crew of six men for a day.

Cone-shaped distributors are more economical of material than the old-fashioned pouring pot with a fan-shaped nozzle. They are also far more easy to operate in windy weather.

Advantages and economies of the above methods of tar distribution are apparent. The cost of the barrels, amounting to four to five cents per gallon, is immediately eliminated. The costs of handling and filling are eliminated for the producer of the bituminous material. This of course is reflected in the price paid for the product. Considerable saving is made in the cost of the distribution of the tar on the road, such as unloading from trucks, dumping to the side of the road, opening the barrels, filling small tar kettles and heating the material by inefficient methods.

Concrete Patching

In cases where the concrete pavement becomes shattered or is broken down in an area of at least one square yard, it is imperative that it be repaired by some other method than the application of bituminous material and aggregate.

Such holes must be torn out and it is the best practice to dispose of the broken concrete, not using any of it in making the patch. It is desirable to enlarge the hole in area to a point where but few cracks radiate from, or circle about the hole. The excavation should be made at least one inch below the old concrete, the ragged edge should be as nearly vertical as possible, if anything, undercut, so that the patch will give support to the surrounding concrete. No bituminous treatment should be given to the edges of the old concrete.

The best way of digging out the old pavement is by the use of a large portable air compressor, mounted on a 5-ton trailer and driven by a 30-h. p. gasoline engine. The compressor should be of a capacity sufficient to furnish 125 cu. ft. of air per minute. This will necessitate a 2-cylinder 8 in. x 8 in. compressor. This equipment is easily transported over any area accessible to motor truck haul. A compressor of this size will furnish air for two large concrete breakers, which have been found very effective in digging out and loosening the old concrete. In fact, three men so equipped will accomplish more per day in removing old concrete than will a gang of twelve men using the old method of sledge, pick, crowbar and jack.

A small 7-S building mixer will mix as much concrete per day as the air compressor will prepare holes for. Trucks delivering the aggregate and cement to convenient piles along the road and wheelbarrows feeding the mixer and delivering mixed material to the holes is the most common and, I believe, the most efficient method of doing the ordinary concrete patching job. Where traffic is heavy, the establishment of a small central mixing plant is desirable. With this arrangement, a 14-S mixer should be used and should be fed with a batch hopper or bin which can proportion and feed the mix by gravity. The bin should be fed by a small revolving crane picking the material up from piles where it has been previously dumped from motor trucks. The mixed concrete from a central mixing plant can be distributed to the holes in the pavement either by small Ford trucks carrying one batch of concrete, or by motor buggies. The set-up for the central mixing plant should be made at frequent intervals, say one mile apart along the line of the road to be repaired. The great advantage of a central plant is that it does not clutter up the highway with material, cement and equipment, such as is necessary when the mixing is done with a portable mixer.

In order to facilitate traffic it is desirable to tear out and repair only one side of the road at a time, leaving the other side and shoulder free for passing vehicles. Where the hole in the pavement is at the edge, forms, consisting of 2 x 8's firmly staked, or steel road forms should be used, the patches should be struck off with a strike-board and should be belted—in fact all the first-class methods used in the construction of a new road in the way of workmanship should apply to making patches. One of the most important things is to build the patch so there will be no unevenness in joining the old concrete with the new.

The use of hardeners such as calcium chloride, Cal and hydrated lime is recommended in all concrete used for patching. Experience indicates that about five per cent by weight is the right proportion. It is admitted that the resulting concrete may not ultimately be so strong with the use of hardener as without it, but it takes a permanent set so that it is safe to open the patch to travel within a week, instead of holding it closed the usual length of time. This is of so much greater importance than any other consideration that it makes the use of hardeners imperative.

A new joint filler is now coming into the market which may be of great benefit in the repair of joints and cracks. It is the color of portland cement and will thus eliminate one of the objections to the concrete pavement, namely, its irregular cracks repaired with black material. It has a high resistance to abrasion, is waterproof and does not disintegrate in hot weather. It is a composition of resin and gutta-percha and if it works out as satisfactorily in practice as it has in recent experiments by the U. S. Bureau of Public Roads, it may revolutionize our method of handling small repairs.

Cost Accounting in Products Manufacture

By Mac Hanson

The forms illustrated in former articles under this heading were designed for a factory specializing on small tile only. This system will apply as well to a factory doing a diversified manufacturing business. Let us consider a factory expected to turn out 200 "standard days" output of small tile, 200 days on big tile and 200 days on silo staves.

Two men will wheel in sand, two men run the mixer for little tile and staves, two men run the mixer for big tile, two men operate the little tile machine, two men tamp staves, two men yard staves and little tile in the morning and big tile in the afternoon, and four men operate the big tile machine. The distribution of labor on the big tile machine will be as follows: one machine operator, two cart men, and one bin man stripping. The car system is used in stave making and little tile making. The mix is 1:3 on all products. All three departments are operating at the same time.

A cursory examination of the above lay-out would indicate that the annual overhead burden would be distributed over 600 standard day's output,- 200 days to each department. But a closer study shows that this would be misleading—give us wrong cost data; for the two men tamping staves will use up only 43 sacks of cement a day, 7 staves per sack, for 300 staves. The

All departments

OVERHEAD EXPENSE ESTIMATE SHEET - Based on
200 days operation L.M.
200 " " B.M.
200 " " staves

INCIDENTALS	Annual	Combined daily total	Staves per day 8/41	Little Tile per day 15/41	Big Tile per day 18/41
Coal-1½tons @ $5.00	$ 1500.00	7.50	1.47	2.74	3.29
Water	120.00	.60	.12	.22	.26
Lights	30.00	.15	.03	.05	.07
Oil & Grease	40.00	.20	.04	.07	.09
Blacksmithing	400.00	2.00	* .25	* .80	* .95
Small tools	40.00	.20	.04	.07	.09
Frt.& drayage, inward	60.00	.30	.06	.11	.13
Exps.steaming products	200.00	1.00	.20	.35	.45
Compensation Insur.	440.00	2.20	† .55	† .55	† 1.10
Chore(or indirect)labor	600.00	3.00	.60	1.05	1.35
SUB-TOTALS	3430.00	17.15	3.36	6.01	7.78
VARIABLES					
Repairs to machinery	100.00	.50	.10	.18	.22
Int. on money in products	1200.00	6.00	1.20	2.20	2.60
Taxes	400.00	2.00	.40	.73	.87
Culls & Breakage	2000.00	10.00	2.00	3.50	4.50
Yard losses & Shrinkage	400.00	2.00	.40	.73	.87
SUB-TOTALS	4100.00	20.50	4.10	7.34	9.06
FIXED CHARGES					
Repairs to buildings	100.00	.50	.10	.18	.22
Depreciation of Buildings	200.00	1.00	.20	.35	.45
Depreciation of machinery	1000.00	5.00	1.00	1.75	2.25
Interest on money invested	-	-	-	-	-
Boiler insurance	50.00	.25	.05	.09	.11
Fire insurance	50.00	.25	.05	.09	.11
Tornado insurance	10.00	.05	.01	.02	.02
Superintendent's salary	1000.00	5.00	1.00	1.75	2.25
SUB-TOTALS	2410.00	12.05	2.41	4.23	5.41
ADMINISTRATIVE					
Office overhead	80.00	.40	.08	.14	.18
Office supplies	30.00	.15	.03	.05	.07
General manager's salary	2500.00	12.50	2.50	4.50	5.50
Clerks salary-(2)	1040.00	5.20	1.04	1.82	2.34
Auto expenses	200.00	1.00	.20	.35	.45
R.R.fares	100.00	.50	.10	.18	.22
Donations & charities	100.00	.50	.10	.18	.22
Association dues-expenses	500.00	2.50	.50	.88	1.12
Life insurance(protection)	1000.00	5.00	1.00	1.75	2.25
Legal expenses	200.00	1.00	.20	.35	.45
Telephone & telegram	100.00	.50	.10	.18	.22
Heat, light, water	100.00	.50	.10	.18	.22
Compensation insurance	20.00	.10	.02	.04	.04
SUB-TOTALS	5970.00	29.85	5.97	10.60	13.28
SELLING					
Ofice overhead	20.00	.10	.02	.03	.05
Office supplies	30.00	.15	.03	.05	.07
Sales Manager's salary	1800.00	9.00	1.80	3.25	3.95
Auto expenses	300.00	1.50	.30	.53	.67
Advertising	200.00	1.00	.20	.35	.45
Collecting	150.00	.75	.15	.26	.34
Bad Accounts	300.00	1.50	.30	.53	.67
Adjustments & discounts	100.00	.50	.10	.18	.22
Loading outbound	450.00	2.25	.45	.81	.99
Freight outbound	400.00	2.00	.40	.73	.87
SUB-TOTALS	3750.00	18.75	3.75	6.72	8.28
GRAND - TOTALS	19660.00	98.30	19.59	34.90	43.81

* Distributed according to experience
† Distributed according to productive labor

Fig. 1—Overhead Expense Cost Estimate Sheet

two men making little tile will use 75 sacks of cement a day, 40 tile per sack on 5-in. tile, for 3000 ft. output a day, while the four men on the big tile machine will use 100 sacks per day, 3 ft. of 20-in. tile per sack for a daily average of 300 ft.—150 tile of 2-ft. lengths.

A fairer basis of distributing the annual overhead burden then would seem to be, not to charge each department on an equal basis for its standard day's output, but to pro-rate the burden to the standard days of each department in proportion to the tonnage manufactured by each department. This is fair. A basis giving even greater refinement of costs could be outlined but as it entails more clerical work than most factories will afford or would keep up, we will use the "standard day tonnage" basis above mentioned.

We will use as our basis of distributing overhead expenses, the 5-in. tonnage in little tile because it is by far the biggest seller; the 20-in. tonnage in big tile because it will represent the average volume of production in sizes between 14- and 30-in. Staves for all purposes are of one standard size and weight. The standard day's tonnages are then as follows:

Staves	300 staves	@ 53 lbs.	= 8 tons a day
5-in. Tile	3000 ft.	@ 10 lbs.	= 15 tons a day
20-in. Tile	300 ft.	@ 120 lbs.	= 18 tons a day
		Total	41 tons a day

First we must determine what the overhead expenses will be for a combined standard day of the three departments. Then distribute this combined amount to the separate departments in the ratio of 8 : 15 : 18. Fig. 1 is our Overhead Expenses Cost Estimate sheet with this distribution made. Fig. 2 is our Production Cost Estimate sheet on the little mill. Fig. 3 is on the big mill, and a similar sheet is used for staves. These Production Estimate sheets are merely our basis of estimating for purposes of quoting prices before we have made any products, or for bidding purposes, or at least before we have enough cost accounting data proper to guide us in making prices.

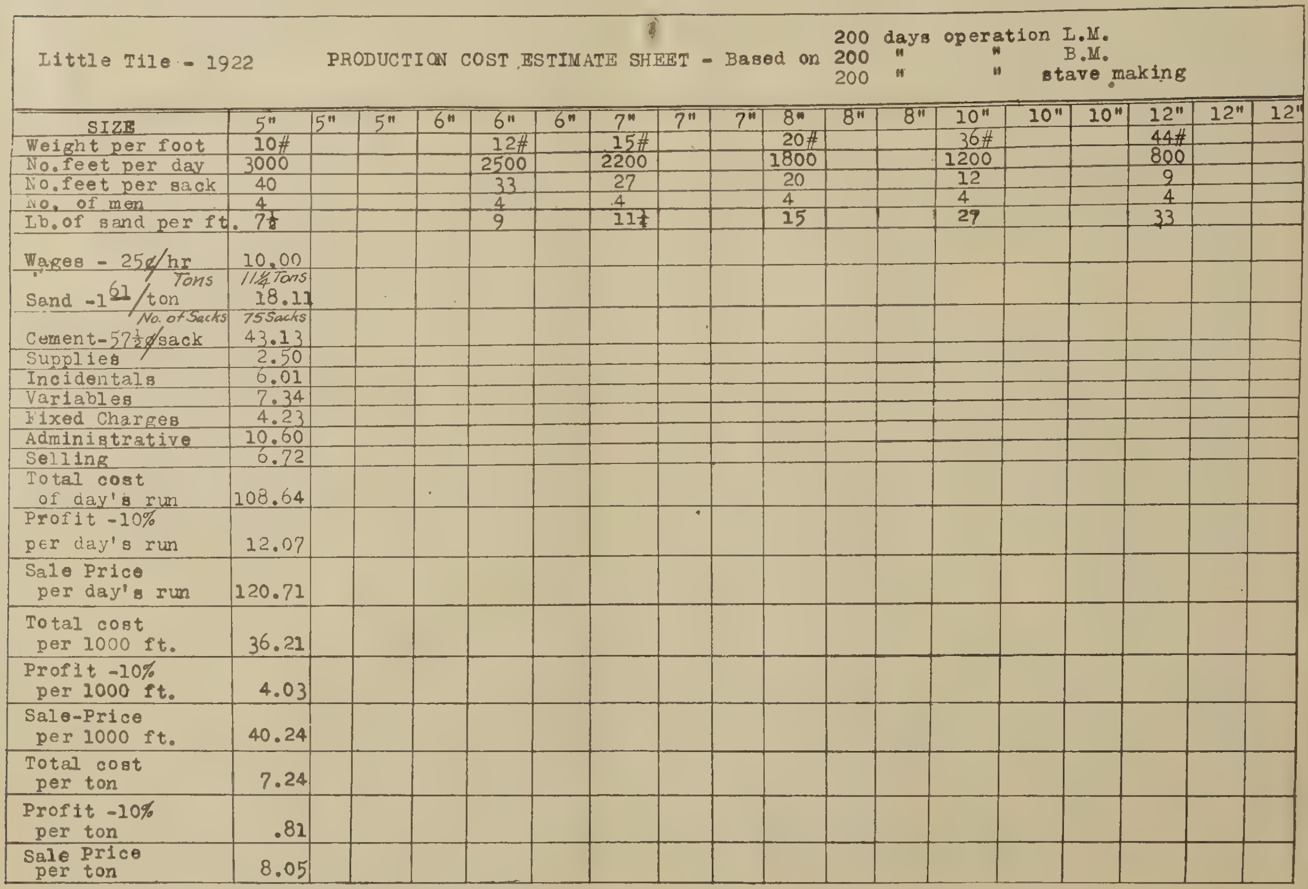
The distribution of productive labor to departments was as follows:

Labor	Staves	Little Mill	Big Mill
2 Men wheeling sand	½	½	1
2 Men mixing, L. M. and staves	1	1	0
2 Men mixing, B. M.	0	0	2
2 Men operating L. M.	0	2	0
2 Men operating staves	2	0	0
4 Men operating B. M.	0	0	4
2 Men yarding products	½	½	1
Totals	4	4	8

From this point on the cost accounting system is worked exactly as explained in our former article on Cost Accounting printed in these columns. That is, the Cost Accounting Estimate sheets and Cost Accounting Actual Expenses sheets gather their data as before explained and the posting is the same.

The two facts in cost accounting which are the hardest for all of us—especially for those who have never attempted to keep a cost finding system—to really appreciate, facts which fail to get under our skin deep enough to make us stop, think, study, act, watch and worry, facts which we recognize theoretically but pay too little attention to practically, are these:

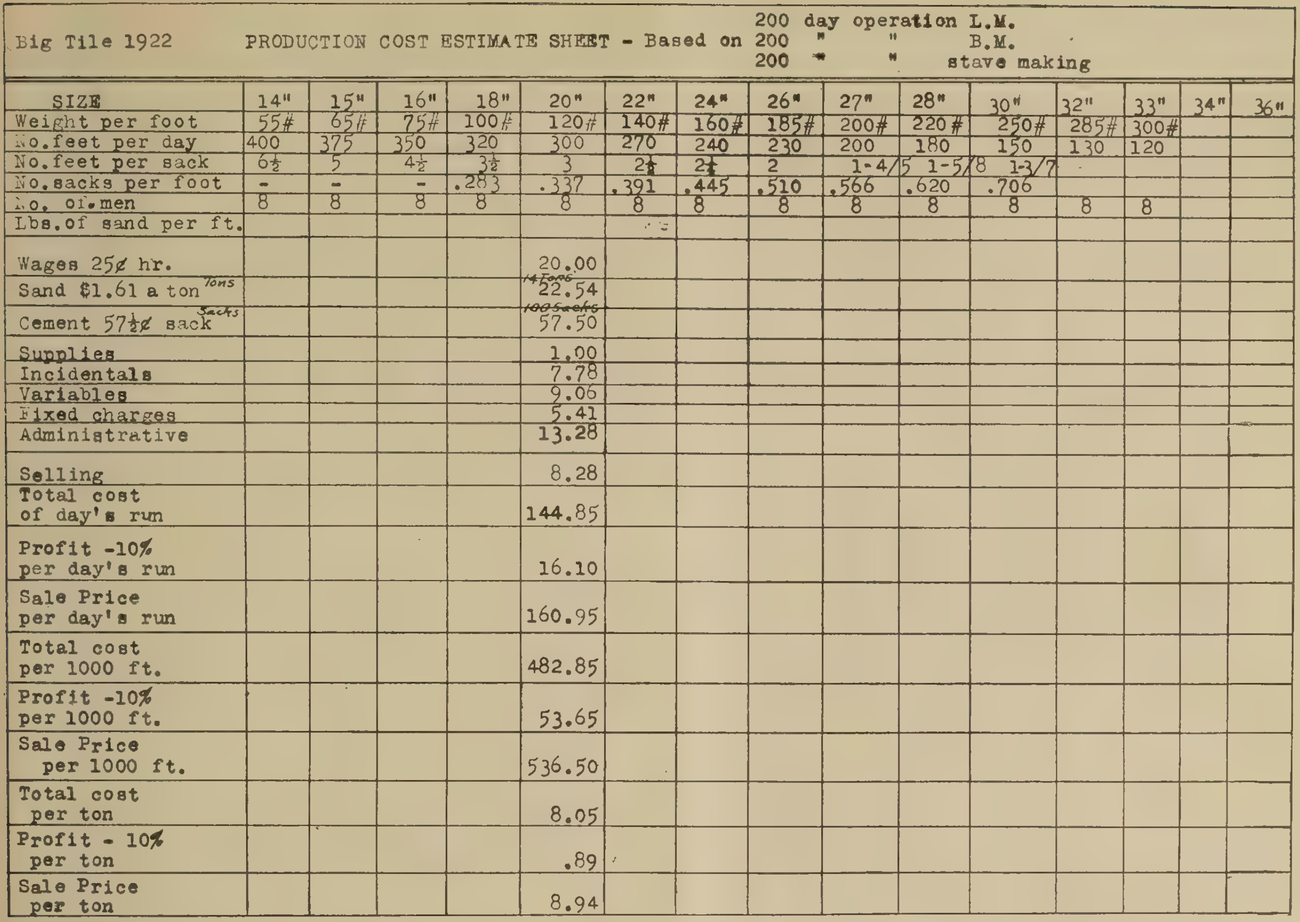
First, the excessively large *number* of different kinds of overhead expenses. Second, the proper and just distribution of these to the various departments of the business. So many manufacturers figure cost by the old rule of thumb method. They set down the Prime Costs—sand, cement, and productive labor—and then add 20% for overhead expenses. This is a very blind, misleading way. It fools them into thinking they are making a profit whereas, all the time, they are making a loss. If you say anything to them about it, they rear back on their dignity and say, "Well, I've got more money in the bank at the end of this year than I had at the end of last year and I



Little Tile - 1922 PRODUCTION COST ESTIMATE SHEET - Based on 200 days operation L.M.
200 " " B.M.
200 " " stave making

SIZE	5"	5"	5"	6"	6"	6"	7"	7"	7"	8"	8"	8"	10"	10"	10"	12"	12"	12"
Weight per foot	10#				12#		15#			20#			36#			44#		
No.feet per day	3000				2500		2200			1800			1200			800		
No.feet per sack	40				33		27			20			12			9		
No. of men	4				4		4			4			4			4		
Lb.of sand per ft.	7½				9		11¼			15			27			33		
Wages - 25¢/hr	10.00																	
Tons Sand -1 61/ton	11¼ Tons 18.11																	
No. of Sacks Cement-57½¢/sack	75 Sacks 43.13																	
Supplies	2.50																	
Incidentals	6.01																	
Variables	7.34																	
Fixed Charges	4.23																	
Administrative	10.60																	
Selling	6.72																	
Total cost of day's run	108.64																	
Profit -10% per day's run	12.07																	
Sale Price per day's run	120.71																	
Total cost per 1000 ft.	36.21																	
Profit -10% per 1000 ft.	4.03																	
Sale-Price per 1000 ft.	40.24																	
Total cost per ton	7.24																	
Profit -10% per ton	.81																	
Sale Price per ton	8.05																	

Fig. 2—Production Cost Estimate Sheet on Little Mill



Big Tile 1922 PRODUCTION COST ESTIMATE SHEET - Based on 200 day operation L.M.
200 " " B.M.
200 " " stave making

SIZE	14"	15"	16"	18"	20"	22"	24"	26"	27"	28"	30"	32"	33"	34"	36"
Weight per foot	55#	65#	75#	100#	120#	140#	160#	185#	200#	220#	250#	285#	300#		
No. feet per day	400	375	350	320	300	270	240	230	200	180	150	130	120		
No. feet per sack	6½	5	4½	3½	3	2½	2¼	2	1-4/5	1-5/8	1-3/7				
No. sacks per foot	-	-	-	.283	.337	.391	.445	.510	.566	.620	.706				
No. of men	8	8	8	8	8	8	8	8	8	8	8	8	8		
Lbs. of sand per ft.															
Wages 25¢ hr.					20.00										
Sand $1.61 a ton Tons					14 Tons 22.54										
Cement 57½¢ sack Sacks					100 Sacks 57.50										
Supplies					1.00										
Incidentals					7.78										
Variables					9.06										
Fixed charges					5.41										
Administrative					13.28										
Selling					8.28										
Total cost of day's run					144.85										
Profit -10% per day's run					16.10										
Sale Price per day's run					160.95										
Total cost per 1000 ft.					482.85										
Profit -10% per 1000 ft.					53.65										
Sale Price per 1000 ft.					536.50										
Total cost per ton					8.05										
Profit - 10% per ton					.89										
Sale Price per ton					8.94										

Fig. 3—Production Cost Estimate Sheet on Big Mill

don't owe anybody a cent. I lived well during the year, too, etc." They consider such a fact as indisputable proof that they are making a profit. In fact it's hard for most of us who know better to keep from feeling thoroughly satisfied with such a situation.

What is wrong with such an argument? Where is the error—the joker? It is this. Every manufacturer's buildings and machinery are depreciating each year. Machinery is also "obsoleting." Repair expenses—such as painting or re-roofing—are accruing each year. Such repairs may not have to be met for two or three years hence, but they are an accrued expense of this year and every year. Extraordinary contingencies are liable to develop at any time. To be prepared for all of these things and many others like them, special funds must be built up from year to year. These special funds are our estimate of the accrued expense of that year for the various items mentioned. That is to say, every manufacturer should have the following special funds on hand, at least: Reserve for Depreciation of Machinery; Reserve for Depreciation of Buildings; Reserve for Repairs and Upkeep; Reserve for Extraordinary Contingencies; etc. The increase in these funds each year is not an increase in profits accumulated; it is an increase in expenses as yet unpaid because not due—that is, accrued expense.

The rule-of-thumb man doesn't understand this matter. He underbids others, all the time thinking he is bidding safely and making a profit. He is not a fool. He is merely ignorant of his true costs. It is the solemn duty of every enlightened manufacturer to make such a man see the light. This takes patience and long persistent effort. But don't give up, for your own sake and for the good of the business as a whole. The excessively large number of different kinds of overhead expenses will be appalling to our rule-of-thumb man when you finally make him see it. It is appalling to the rest of us, too.

So many manufacturers, when trying to reduce costs, begin by cutting wages. This is the most foolish thing they can do. Wages should be the last thing to be cut. Only as a last resort should they be reduced and then your men should be made to see why it is absolutely required. Look at the Production Cost Estimate sheets a moment. Labor isn't the big expense. It is overhead expense that is the single big expense. Overhead Expense is 2½ times as big each day as productive labor. When trying to reduce costs begin on overhead

PRODUCTION COST ESTIMATE SHEET
200 DAYS OPERATION L. M.
BASED ON 200 DAYS OPERATION B. M.
200 DAYS OPERATION STAVES
STAVE MAKING 1922

WEIGHT PER STAVE	53 LBS
NO. STAVES PER DAY	300
NO. STAVES PER SACK	7
NO. OF MEN	4
LBS. OF SAND PER STAVE	40 LBS.
WAGES	$10.00
(6 Tons)	6 Tons
SAND—$1.61 A TON	$9.66
(43 Sacks)	43 Sacks
CEMENT 57½c	$24.73
SUPPLIES	
INCIDENTALS	3.36
VARIABLES	4.10
FIXED CHARGES	2.41
ADMINISTRATIVE	5.97
SELLING	3.75
TOTAL COST OF DAY'S RUN	63.98
PROFIT—10% PER DAY'S RUN	7.11
SALE PRICE PER DAY'S RUN	71.09
TOTAL COST PER STAVE	.213
PROFIT—10% PER STAVE	.024
SALE PRICE PER STAVE	.237
TOTAL COST PER TON	8.05
PROFIT—10% PER TON	.89
SALE PRICE PER TON	8.94

Fig. 4—Production Cost Estimate Sheet for Staves

expenses. If that doesn't accomplish your needs then it is time to consider cutting wages.

Now in regard to the second fact,—the proper and just distribution of overhead expenses to each department and job. If these expenses are not properly and justly distributed, then—although we know all of our overhead expenses and know exactly what the annual total of each one is—even then we are likely to be fooling ourselves. We may even lose money, or at best merely break even, if proper distribution isn't made. It is almost certain we won't be making all the profit we ought to make and are entitled to make. Big corporations that have millions invested, with an office full of clerks, accountants, and comptrollers, find it difficult to correctly distribute overhead expense. How much more so do we concrete products manufacturers who do not have all of these experts. Just to illustrate—a certain big corporation manufacturing all sizes of electric motors, instructed its salesmen to push the big motors and lay off the small motors, the ½ h. p. and ¼ h. p., as much as possible, because they figured that the long profit was in the big motors and the small profit in the small motors. Profits did not pile up as they should have nor as anticipated. Finally a professional accounting firm was called in to ferret out the trouble. After several weeks investigation they found and proved to the management that the reverse was the true fact.

I know, from personal knowledge, that the majority of the concrete products men who specialize on drain tile, figure their costs on the tonnage basis only—the basis I have used in this article in spreading overhead expenses. I deliberately used that basis in this article because I am primarily concerned in getting the man interested who does not at present have a cost system.

Nevertheless, that basis does not go into enough detail to show the actual and true state of affairs. Another manufacturer from Iowa and I argued against that basis at the convention of the American Concrete Products Association two years ago, but we apparently failed to convince anyone.

I am a mere novice at this cost accounting business, but I will suggest a basis for what it is worth. I will not discuss it. If you think it is fair you can work out your own distribution on the suggested basis. I am in favor of going into more detailed refinement about this matter of distributing overhead costs. The retail prices of our products are affected greatly by the competition received from shale and clay tile, and in silo sales by the various other kinds on the market. Experience has shown practically every concrete products manufacturer that he can get a longer profit in big tile (and the bigger the size, the longer the profit) than he can get from silos; and a longer profit in silos than in little tile. Therefore I am in favor of distributing the overhead charges not merely on a "standard day tonnage" basis, but on a "standard day tonnage percentage of profit" basis. Let that department—yes, let us go farther than that—let that size of tile in each department, which shows the greatest percentage of profit per ton-day, also carry the greatest proportion of the overhead charges.

Now do not pooh-pooh this idea. We are supposed to be men of common sense. I am telling you this with the unselfish idea of trying to show you a way of making a bigger profit. Give it careful thought. If you think it is right, act on it. If not, there is no harm done.

There is one more improvement on this system of cost finding that I have not adopted myself, but know that I should. It is this. The business should be departmentalized more than I have indicated. In this article I used only three departments of manufacturing, viz: stave making department, little tile making department, big tile making department. Each of these included its share of the expenses of power, mixing, making, curing, and yarding. Since the only way to know whether any one end of the game is costing more than it should, whether its costs are increasing or decreasing, etc., is to have the costs of that end of the game thoroughly segregated and collected in total, therefore I am in favor of having the following departments for cost accounting purposes,—Power, Mixing, Curing, Yarding, Stave making, Little Tile making, Big Tile making. Then we can tell exactly how much power is costing us, what is the cost of mixing, of curing, etc. We can discover the leaks of each, can investigate and plan to reduce the expense of each. The matter of working out a system of distributing the overhead expenses to each, properly and justly, should not be difficult after a little consideration.

Let us spend more money for clerk hire in order to make our cost systems tell us more about the what, why and where of it. Such money will pay the biggest returns of any one thing we can do. Cost accounting is the "stitch in time" by which we are enabled to save all those big losses due to a lack of a cost finding system,—"the stitches nine". A stitch in time saves nine.

Campbell Machine Finishes Floors, Walls and Ceilings

Occasionally a concrete floor job goes bad—more often in the winter months when a sudden frost catches the engineer unprepared; and very often the floors are frost struck. It may not go in very deep, but enough to leave the troweled finished surface scaly, and eventually a dusty floor. The loose cement is usually not more than $\frac{1}{16}$ of an inch thick and will eventually wear off, but it may take years. Grinding machines sometimes get the contractor out of his difficulty.

The manufacturers say that a man with a Campbell No. 4 heavy duty floor surfacing machine will usually rub or grind from 2000 to 3000 sq. ft. in eight hours, leaving the surface smoother than the average troweled surface. Stopping the wear stops the dust.

The same method can also be applied to cleaning a floor just before the job is turned over to the owner. It is hard to keep the floor clean while the building is under construction. Men work days trying to clean a floor by hand. Mr. Campbell reports a job where the forms leaked, and the troweled finished floor was not covered until a couple of days after the cement dropped on it.

They covered the floor with shavings and sawdust. The consequence was that there was from ½ to 4 inches of concrete stuck to the floor. Workmen walked on it and tramped the cement into the sawdust leaving the floors in very bad condition.

We agreed to clean the floor for 2c per foot or $2.25 an hour for man, machine and rubbing bricks; or they could rent the machine for $6.00 per day and supply their own bricks.

They accepted the man, machine and bricks at $2.25 an hour. The first two days our man rubbed about 4000 ft. but they were not satisfied. They said the man did not keep the machine running all the time. They said they could do it cheaper by hand. We told them to put ten men on by hand, and if they would do as much in eight hours as the machine, we would rub their job for nothing. They sent out for ten long handled chisels and started their ten men. They had to put on an extra man as foreman. After working their eleven men four hours they cleaned about 600 ft. They spoiled the floor for they drove their chisels through the dirt and into the finished floor. So they stopped them and put on their own men and rented two of our machines.

We made up an iron scroll wheel for one machine to go ahead on the rough places and the other machine came after with the carborundum bricks. There was about 100,000 ft. in all, and I think it cost them about $7.00 per thousand ft. to clean up the job. The same job by hand was costing $26.40 for 600 ft. or a little over $40.00 per thousand feet and spoiled the floor. We have done several jobs for that company since.

We have recently perfected a small machine for base, wall and ceiling work. It often happens that the ceilings give the engineer no end of trouble, on account of the voids and holes that are left when the forms are taken down. We have found in repairing these places, that if the cement is thrown in off the trowel a little at a time, until the hole is filled, and a little more than flush, say, about ½ an inch, and allowed to remain without disturbing the cement until it is well set, it can be ground off flush and the patch will hardly be noticed. In most cases this can be done by hand with a carborundum brick. Where there is a large space to rub, the machine will be found a great labor-saving device. Patching these places and finishing with the trowel, it is very hard to keep the cement in. Just as soon as the trowel goes on it, it starts to come away from the edge. Very often it falls out or starts to crumble around the edge. Although the other method may seem more expensive, it really is the cheapest in the end.

Tests of Adensite Show Interesting Results

Adensite is a new product (proprietary Adensite Co., Inc., New York city), offered to solidify, waterproof, dustproof and harden concrete. A recent pamphlet shows a flow table test and also one for compressive strength, to establish the material's value in adding to the plasticity of concrete mortars. A higher compressive strength is claimed at 28 days with Adensite gauging water than with plain water. Tests by Prof. John R. Lapham, George Washington University, are reported showing that water gains on Adensite at three months and then Adensite picks up in the race at six months. Both tests of specimens were above the average in strength. All these specimens were made up with carefully graded aggregates so that laboratory variations might be reduced to a minimum. At present, Professor Lapham is running a test to show just how much Adensite reduces the surface tension and adds to the wetting power of the gauging liquid.

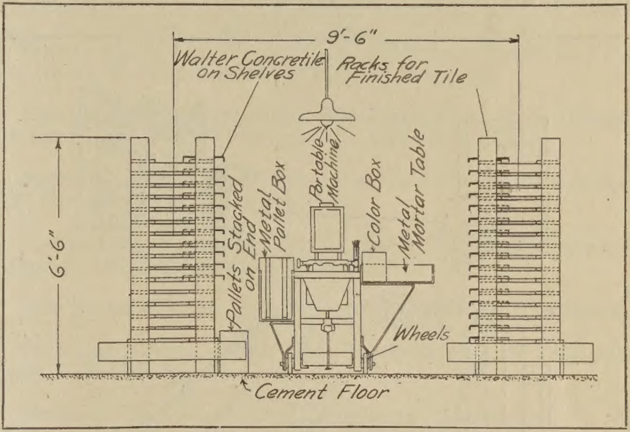
The producers say that concrete made with three gallons of water and one quart of Adensite to a bag batch has been *poured* on the job. The following tests are reported:

Strength Results on 3 x 6 Cylinders of 1:2 Mortar

Age	Water		Compound		Ave. lbs. per sq. in.	Increase %
	No.	Str. lbs. per sq. in.	No.	Str. lbs. per sq. in.		
2 da.	1	1064	19	1591		
	7	1235	25	1584		
	13	1188	31	1587		
	Av.	1162		1587	425	36.5
7 da.	2	2264	20	2519		
	8	2433	26	2814		
	14	2312	32	2785		
	Av.	2336		2706	370	15.9
14 da.	3	2935	21	3523		
	9	3312	27	3226		
	15	3099	33	3403		
	Av.	3115		3384	269	8.7
28 da.	4	3768	22	4343		
	10	4029	28	4099		
	16	4167	34	4246		
	Av.	3988		4229	241	6.0
3 mo.	5	5271	23	5548		
	11	5738	29	5268		
	17	5612	35	5166		
	Av.	5540		5327	-213	-4.0
6 mo.	6	5991	24	5916		
	12	6237	30	5330		
	18	4922	36	5405		
	Av.	5717		5550	-167	-3.0

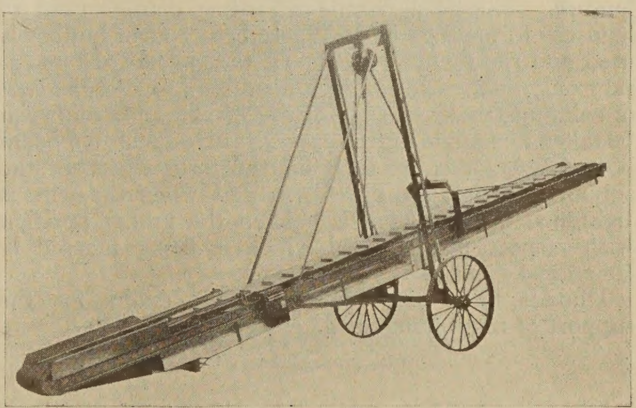
New Model Walter Concretile Machine

The Walter Concretile machine, now manufactured by the Crawfordsville Foundry Co., Crawfordsville, Ind., is produced in a new model with wheels, to be moved down the aisle between the racks upon which the tile are placed for curing. This is to avoid the many steps taken by the prevalent method of carrying the tile as made from the machine a varying distance to the racks, as the racks are filled.



New literature on this equipment emphasizes the importance of a new pallet which has cleats on the molding surface so that the concrete does not slip on the pallet under the pressure of the trowel bar. This feature, it is claimed, adds greatly to the density of the tile, making them about 18% stronger than tile manufactured on the old style smooth-faced pallets. The illustration is a vertical elevation of racks and machines showing the position of the equipment with relation to the racks where the tile are put to cure for the first twenty-four hours. On the following day, the pallets are stacked alongside the racks where they are convenient for use on the next round of the machine.

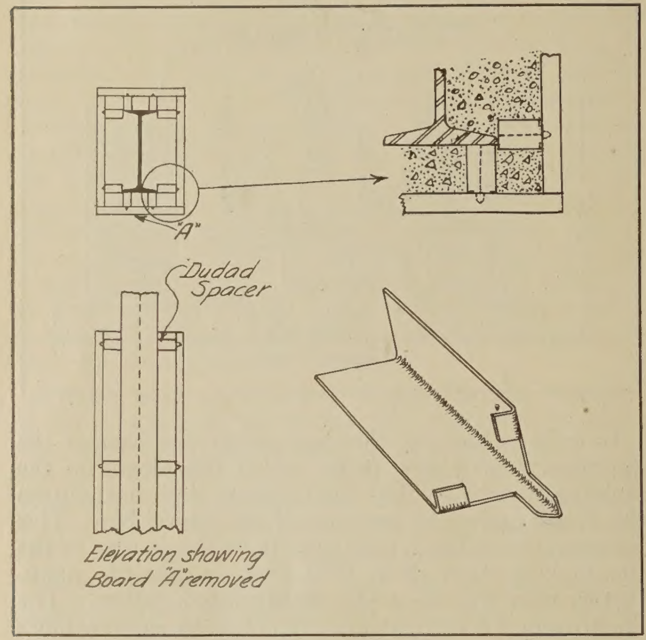
Portable Belt Conveyor at Low Price



The picture shows a type of portable loader made by the Link-Belt Co. on which quantity production has recently made possible a considerable price reduction. The Cub, as it is called, is used for loading cars, trucks and wagons, with any loose material such as coal, sand stone, gravel, assisting in speeding up the hand labor that is employed in work of this kind.

Dudad Form Spacer

The accompanying illustrations show the Dudad spacer and how it is used for insuring a correct and uniform thickness of fireproofing on the outside of structural steel shapes in columns, beams and other structural members. Dudad form spacers are put on the market by the Con-Form Specialty Co., Detroit, Mich. In use, the Dudad, which is made of one piece of sheet metal, is attached to the form by driving the projection on one end of the spacer into the form in the proper place until the end of the spacer is seated against the form. The Dudads are placed so as to come against the steel which is to be surrounded by fireproofing, and hold the form the proper distance away from the steel.



The spacers are made in any length with an adjustable die to give the correct thickness of fireproofing concrete to conform with the regulations in the locality where the construction work is being carried on.

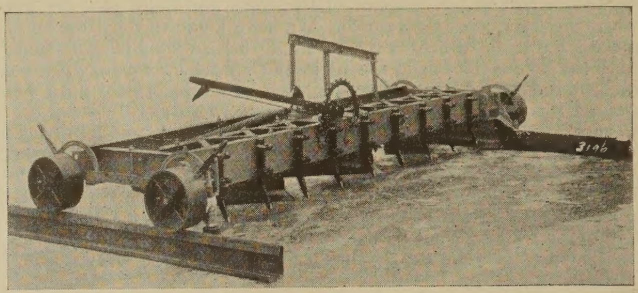
The spacing of the Dudads in a longitudinal direction or parallel to the axis of the column or beam, is to a certain extent governed by the thickness of the form lumber. This is also true regarding clamps used to hold the forms together. Where heavy form lumber is used and the sections are short, the spacers are necessary only at the ends of each form section. In the case of columns, the frequency of the spacing of clamps can be taken as a guide for the spacing of Dudads. On beam bottoms, Dudads are used on the form wherever the supporting wires are placed, so that when the wire is tightened up, the form is held in the proper position with respect to the steel which is being incased in concrete.

Dudads have never been used as chairs for the support of reinforcing steel.

Batcherplant, a 32-page catalog, 7-¾ x 10-¾ in., describing and illustrating very profusely construction jobs calling for equipment of this kind. The publication points out reasons for its development: (1) requirements of state and engineer's specifications for the accurate measurement of sand and stone; (2) the necessity for a central proportioning plant as a part of modern road building and concrete construction to cut costs and speed up the measurement of aggregates. This equipment was used in 1922 construction season on more than 150 construction jobs in 28 different states. The publication is of unusual interest; the equipment itself is of the suspension bin type for one-man operation.

Steel Subgrader With Scarifier Teeth

The accompanying picture shows the new Lakewood Steel Subgrader, developed from the Lakewood Woodframe Subgrader which has been used for a number of years. It is built to meet a demand for a heavier unit which could be equipped with scarifying teeth on the front member to break up the subgrade ahead of the blades. Its use is to plane down the subgrade to the exact depth for the road slab. It travels on the side forms and is pulled by a roller or tractor.



Lakewood Subgrader with Scarifier Teeth

Improved Schramm Portable Air Compressor

Radical changes have recently been made in the governing, ignition and fuel feed systems of the Schramm line of portable engine-driven air compressor outfits, manufactured by Schramm, Inc., Westchester, Pa. The original principle of direct-connecting the engine to the compressor by means of a two-throw crankshaft is still used, as it has been found to be the most satisfactory design. The crank arms are set 180° apart and while the engine connecting rod and piston are traveling in one direction, the compressor connecting rod and piston are traveling in the opposite one, insuring a perfectly balanced outfit.

Schramm Portable Air Compressor

The amount of pressure obtained from these outfits is in direct proportion to the amount of air used by the pneumatic tools. This automatic feature is obtained by the pressure regulator on the compressor, which can be adjusted by the operator while the machine is in motion.

Six sizes in which these outfits are built range from 15 to 140 cu. ft. of free air per min. Units are designed to meet the requirements for rock drilling on road, sewer, foundation and quarry work, street repair work, calking and testing pipe lines, tamping, sand blasting, etc.

Trade Publications

Seven Reasons Why the Remmel Mixrite is a Better Mixer—circular of the Remmel Manufacturing Co., Kewaskum, Wis., describes and illustrates a number of types from small hand-machines to much larger power equipment, some with pneumatic tires and trailer-mounted. The seven reasons given in the circular are: easy on the engine, easy on the men, easy on the pocketbook, side-gear drive, all-metal construction, drum tilts both ways, drum always in gear. Mixrite No. 20-C is for half-bag batches, length overall 8 ft., width overall 37 in., shoveling height 3 ft. 8 in., capacity 4½ cu. ft. wet, 7 cu. ft. dry. The No. 6 machine is for 2 cu. ft. wet, approximately one wheelbarrowful, height 4 ft. 6 in., width 3 ft. 4 in., shoveling height 3 ft. 6 in., requiring 1½ H.P. engine, with a drum speed of 27 R.P.M.

Western Elevating Grader, 1923 Model—an 8-page, illustrated bulletin, 8½ in. x 11 in., issued by the Western Wheeled Scraper Co., Aurora, Ill., describing equipment especially adapted for use with a heavy tractor. It has a new elevator, an improved disc, new hitch, a sturdier frame, an improved front bolster, and other features.

The Chisholm-Moore Mfg. Co., Cleveland, Ohio—a new circular and a complete booklet of instructions, *Details of Installation on the Atlas Carryal Overhead Conveying System.* Drawings and complete notes on installation, with information as to the practical, cost-cutting, labor- and wear-saving characteristics of the Truck system, are given.

Organizations

American Concrete Institute; Harvey Whipple, Secretary, 1807 East Grand Boulevard, Detroit. Convention February 25 to 28, incl., 1924; place undecided.

American Concrete Pipe Association; M. W. Loving, Secretary, 111 West Washington St., Chicago.

American Engineering Standards Commission; Dr. P. G. Agnew, Secretary, 29 W. Thirty-ninth Street, New York City.

Associated General Contractors of America; G. W. Buchholz, Secretary, 1038 Munsey Bldg., Washington, D. C.

Associated Metal Lath Manufacturers; 123 W. Madison St., Chicago; Wharton Clay, Commissioner.

Building Officials Conference; Rudolph P. Miller, President, Fred W. Lumis, City Hall, Springfield, Mass., Secretary.

Iowa Cement Stave Silo Association; H. E. Kilmer, Secretary, Oskaloosa, Ia.

Iowa Concrete Products Association; Ross Dowell, Secretary, 405 Hubbell Bldg., Des Moines.

Mid-West Concrete Products Association; D. R. Donlen, Secretary-Treasurer, 4340 Marcy St., Omaha, Neb.

National Association of Manufacturers; John E. Edgerton, President; Henry Abbott, Treasurer; George S. Boudinot, Secretary, 50 Church St., New York City.

Twenty-eighth annual convention of Nation's Industry, May 14, 15, 16, Waldorf-Astoria Hotel, New York City.

The National Concrete Stave Silo Association; W. G. Kaiser, Secretary, 111 West Washington St., Chicago.

National Crushed Stone Association; A. P. Sandles, Secretary, 405 Hartman Bldg., Columbus, Ohio.

National Housing Association; Lawrence Veiller, Secretary and Director, 105 East 22nd St., N. Y. C.

The National Lime Association; Mather Bldg., Washington, D. C.

Fifth Annual Convention, Hotel Commodore, New York city, June 13, 14, 15, 1923.

National Sand and Gravel Producers' Association; T. R. Borrows, Acting Secretary, 903 Munsey Bldg., Washington, D. C.

Portland Cement Association; William M. Kinney, General Manager, 111 West Washington Street, Chicago.

Wisconsin Concrete Products Association; D. R. Collins, Secretary-Treasurer, Milwaukee.

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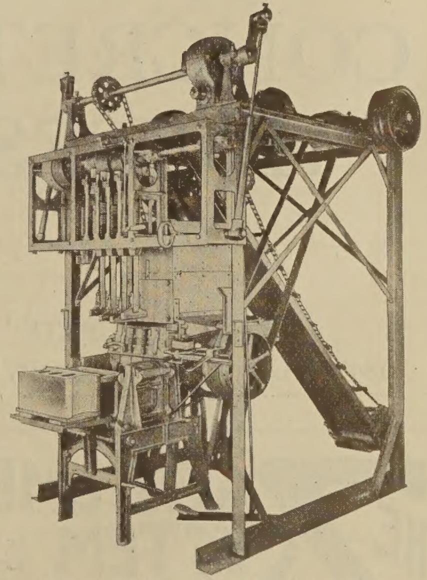
For the rapid production of high-class brick and block, these machines are unbeatable.

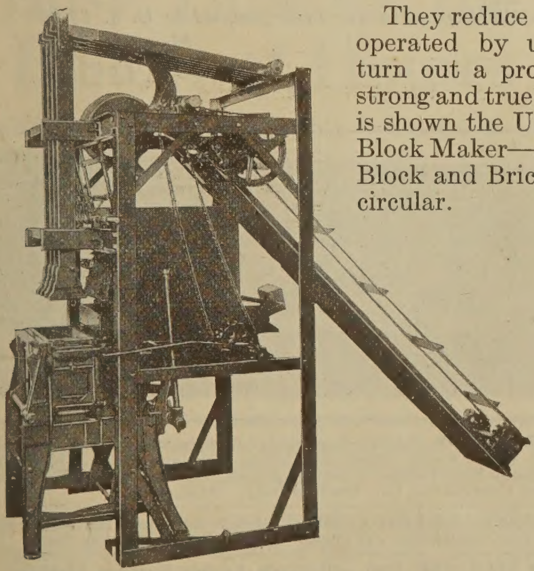
They reduce labor cost, are easily operated by unskilled labor and turn out a product that is dense, strong and true to size. At the right is shown the Universal High Speed Block Maker—at the left, the Junior Block and Brick Machine. Ask for circular.



Showing the Universal High Speed Block Maker

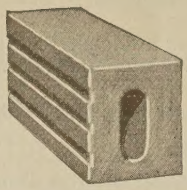
We also build Steel Rack Cars for products plants, Hand Block Machines, the Universal Jigging Machine for cast concrete.

Ask for Special Circulars.

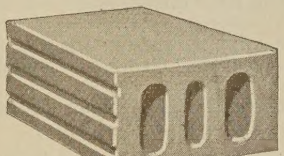


Showing the Universal Junior Machine

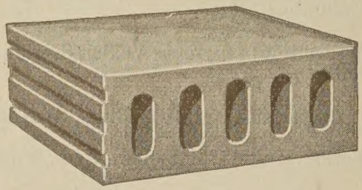
Universal Concrete Machinery Co.
Foote of Alexander St. Peoria, Ill.
Mid-Western Distributors:
Thomas W. Noble & Co. 35 So. Dearborn St., Chicago, Ill.



5 x 4 x 12″
Backup Tile



5 x 8 x 12″
Backup Tile



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Also Partition Tile
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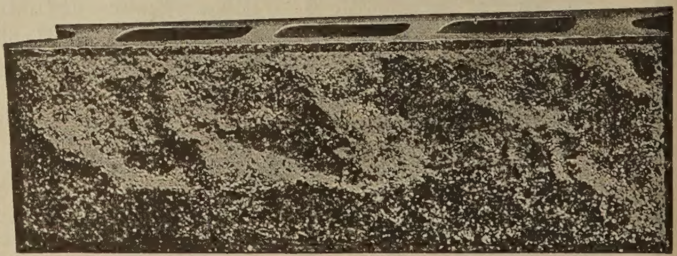

LINER ADVERTISEMENTS

Received Too Late to Classify

MIXERS FOR SALE—Koehring concrete mixer (paver), traction wheels, steam, Wachs engine, distributing boom and bucket. Price $2200.00 Also Austin No. 11 mixer, 2 Maney graders, Rumely OILPULL tractor. The Sterling Construction Co., Medford Bldg., Akron, Ohio.

NEWEST AND BEST CEMENT BRICK and block machines, mixers, sack balers,—catalogue, cut prices. William Barten, Gordon, Nebr.

FOR SALE—1000 iron pallets for Anchor Stripper Machine. Also 1000 Ideal pallets at 15c each f.o.b. cars. Davis Ewing Concrete Co., Bloomington, Ill.